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THE MEASUREMENT OF RESISTANCE.

THE measurement of electrical resistance is a branch of electrical science which has seen most remarkable developments during the last fifty years. Not the least noteworthy point about it is the commercial importance which attaches to the results of such measurements, quite apart from their scientific aspect. Perhaps the most important application is the electrical pyrometer, which only twenty years ago was lying under the ban of an adverse criticism of an influential committee of the British Association, and, as it then seemed, had little to recommend it on the score of accuracy or convenience. More than ten years elapsed before anything material was done to corroborate or disprove the conclusions arrived at by the British Association Committee, but when a thorough and impartial examination was entered into, it was found that mechanical and not electrical difficulties alone stood in the way of success. Now, we rely upon the electrical resistance of a pure platinum wire for the measurement of temperatures; even in the chemical laboratory it is displacing the mercury thermometer, while the elaborate thermometric arrangements which were necessary in olden days, when a greater accuracy was desired than could be obtained by the use of mercury in a glass tube, are dispensed with, and a measurement of electrical resistance gives all the information which the most precise experimenter could wish for. The same line of evolution has led up to the production of the bolometer and micro-radiometer, which have proved such able instruments in the hands of eminent scientific men. Such diverse uses as the measurement of temperature of electric ovens and hot plates, the specific heat of aniline, the temperature at which welding takes place in the Thomson process of electric welding, the thermal effects at temperatures about $-200°$ C., and the heating of insulated wires, the temperature of a blast furnace or of the flues in a refuse destructor, show the applicability of pyrometers based on electrical effects. The day has not yet arrived for a complete bibliographical treatment of such methods, but when it does, a very extensive literature will require to be examined, and a large number of exhaustive researches, the results of which are buried in the transactions of sundry learned societies, will be brought to light.

In electrical engineering practice it is probable that resistance measurements are more common than any others. They are taken by a process or series of processes which involve something more than the mere reading off of the position of a pointer on a dial, and those which have any claim to be called "measurements of precision" require considerable skill and experience as well as a searching examination for instrumental deficiencies before being admitted to that category. One class of measurements—absolute deter-

minations of the specific resistance of mercury and of the value of the ohm—has itself an extensive record, while investigations on the specific resistance of copper and of its temperature co-efficient are giving values from which a true mean may at an early date be taken for general use. Despite all that has been done, however, we are yet at a loss to fix upon any value which may reasonably be regarded as a true one and a final settling of the question which for well nigh forty years has been before the scientific world. Considering the importance which attaches to the results of many resistance measurements, it may be useful to consider the range over which they can be made and the accuracy attainable. We will set aside such methods as involve a direct determination, or as they are generally termed "absolute measurements," and confine ourselves to comparisons between one which is taken as a unit, provisional or arbitrary, for the time being, and another whose value is required in terms of the unit. We are quite ready to accept the statement made by Professor Viriamu Jones that the suggestion made by Lorenz many years ago for the absolute determination of the ohm may be applied with confidence to ascertaining the values of low resistances which it is intended to employ in practice. Even in this case, however, comparison-methods will not be deprived of their present utility, as Lorenz's method is not suitable for values such as are most generally met with, nor is it of much moment that means should be devised for directly obtaining larger values so long as the Board of Trade remains the guardian of a concrete and arbitrary unit, the English legal ohm, which is at the same time the international ohm, and likely to be used pretty well universally.

The present range and accuracy in the measurement of electrical resistance has been recently considered by Mr. Herschel C. Parker, who gives some interesting figures bearing on these points in the current issue of an American magazine. Since the measurement of electrical resistance claims one of the foremost positions among physical determinations for range and accuracy, it is useful to examine the foundations upon which such a claim rests. The ordinary form of plug Wheatstone bridge is provided with proportional coils giving ratios of unity, 10 or 100, and the variable arm comprises a set of resistances adjustable from 1 ohm up to 11,110 ohms. Nominally, the inferior limit of measurement is $\frac{1}{100}$th of an ohm, and the superior $1\frac{1}{10}$th megohms. Practically, about $\frac{1}{10}$th ohm is the lowest which can be obtained with reasonable accuracy, so that the range is from 1 to about 10,000,000. This is often expressed by saying that the Wheatstone bridge is analogous to a balance which could compare masses between the limits of 1 grain and 14 tons. If we do not limit ourselves to the Christie form of bridge, but consider the various methods which are adopted for higher or lower values than those mentioned, Mr. Parker's statement may be accepted without demur. He says that the limits, from theoretical and practical considerations, may be placed at $\frac{1}{10000000}$th of an ohm for the lower, and ten million million ohms for the higher, or a range of from one to one hundred million million millions. Throughout this range the scale is uniform. Measurements are easily made in all parts of it with an accuracy varying from one to one-hundredth of 1 per cent.; difficulty is only met with at the extreme limits. On the other hand, while it is a matter of little difficulty to compare two resistances, a large amount of skill is necessary to obtain the value of any unknown sample in ohms. Temperature variations are of the most importance; second only to these come contact resistances and thermo currents, to say nothing of the physical difficulty of measuring exactly the position of a slider when the wire bridge is used, or to fix precisely the deflection of the galvanometer, if a deflectional method be adopted. The lower limit is fixed by the sensitiveness of the galvanometer and current available. The sensitiveness of galvanometers has been pushed to a point far exceeding that which it is prudent to employ in general. Prof. Nichols has said that the extraordinary demands upon the sensitiveness of the galvanometer made by the researches of recent investigators in the domain of radiation has resulted in the development of a new class of instruments, the delicacy of which has greatly modified the art of using the galvanometer. He, himself, has used an instrument at Cornell University with a figure of merit of 68×10^{-11} ampères with a five-second period and a scale of millimetre divisions. When the period was increased to 20 seconds, the figure of merit rose to $1{\cdot}5 \times 10^{-11}$ ampères, the scale being 300 centimetres from the instrument. And this was for an instrument of a resistance of only 140 ohms. Paschen has used a galvanometer for the exploration of the very weak spectra afforded by the diffraction grating, that gave $1{\cdot}6 \times 10^{-11}$ ampères for 1 millimetre, 20 ohms resistance, a period of 30 seconds, and a scale at 270 centimetres distance. As an example of good practice, we may quote Callendar's work on the practical measurement of temperature, as given in the *Philosophical Transactions* for 1887. Ratios of resistances could be determined, if the temperature of the box remained constant, with an error of only about ·00002. Using a galvanometer of $14\frac{1}{2}$ ohms, and unknown resistances lying between 5 and 15 ohms, one scale division corresponded to a difference of ·0001 ohm when x equalled about 10 ohms; the battery consisted of four to six Leclanché cells working through a circuit of about 500 ohms. Four figures could be obtained directly from the bridge reading, and a fifth by interpolation. There the instrumental errors became of importance—if a Post Office form of bridge was used in lieu of the dial pattern, a change of from 499 to 500 ohms meant a difference of 10 in the number of plugs out, and caused an error of one-tenth degree in temperature as ascertained from the resistance of a pure platinum wire. The Board of Trade Laboratory provides means for adjusting resistances within two microhms; the best value obtained was probably that of Kahle, who, using the Reichsanstaldt bridge, readily worked to within 1·4 microhms. This is an accuracy not looked for in many other branches of physics. At the upper end of the range before mentioned, the limiting causes are the sensitiveness of the galvanometer or electrometer, the E.M.F. used, and the insulation of the instruments.

The following comparisons with other physical magnitudes may convey some idea of the meaning of the figures designating the range over which measurements may be taken, although these are also to be grasped more readily by the astronomer than the engineer. The wave length of sodium light is $5{\cdot}9 \times 10^{-7}$ metres, the distance from the earth to the sun is $1{\cdot}5 \times 10^{11}$ metres, the ratio is therefore 1 to $2{\cdot}5 \times 10^{17}$; hence the ratio through which resistances

may be measured is 400 times as great as the ratio of the wave length of sodium light to the distance of the earth from the sun. That is, from ·00059 mm. to a distance that would require more than two days for light to travel. Mr. Parker gives another simile: take a copper bar, the area of the cross section being equal to 1·6 square cm., we may measure the resistance of a length from 1 mm. to 10^{17} metres, a distance requiring about 10 years for radiant energy to traverse, moving with the velocity of light. In the determination of mass, a parallel case would be from a hundred-thousandth of a gramme to a million million kilogrammes. The ratio of 1 gramme to the earth's mass is as 1 is to 1×10^{27}. A thousand volts is about as high as it is possible to go in testing resistances towards the upper limit we have mentioned; even at this pressure electrostatic effects become troublesome in the instruments used, and leakage cannot be altogether ignored. Where the direct deflection method ceases to be applicable, one resorts to a loss of charge test, as proposed by Siemens, and since improved by Lord Kelvin. For low resistances the potential bridges of Kelvin or Heaviside may be used. It may not be generally known that Lord Kelvin was led to design the arrangement bearing his name on being asked to take the resistance of some bars only 6 mm. long by 1 mm. in cross-section, which had been used by Messrs. Calvert & Johnson in an investigation of thermal conductivity. Siemens Bros., Siemens & Halske, Nalder Bros., Elliott Bros., and Queen, have constructed bridges on this principle, which leave little to be desired in point of convenience or accuracy. The Carey-Foster method of comparing two coils of approximately equal value is not so generally practised as it might be, now that a number of well designed interchanging commutators are available. On the whole, the measurement of resistance is in a remarkably advanced state; but special methods may be used to extend the range that we have briefly discussed.

The New Rules of the Board of Trade.

THE new draft regulations and conditions suggested by the Board of Trade and published in another part of this journal, show clearly the process of evolution. The circumstances that have arisen of late in the supply of electricity, have rendered some modification of the old rules necessary. Such an admission, however, will not preclude us from criticising some of the rules that have been put forward for observation. There is no question that the Board of Trade in their regulations are encountering most serious opposition, and we trust that they will be inclined to give the same consideration to what electrical men think, as they have hitherto done. We have reason to believe that the objections to the new rules have been fairly well organised, and if the case of the objectors can be put forward with the ingenuity that has characterised the criticism, we may fairly hope for some relaxation in the suggested regulations. At the same time electrical men ought not to forget that no matter how much the action of the Board of Trade might be considered to be antagonistic to the developments of electricity supply, they are only proceeding in the very laudable desire of adequately protecting the public. The danger that may be caused by a system of electricity supply has been undoubtedly exaggerated, but unfortunately the Board of Trade, in the course of certain investigations, have discovered very serious delinquencies, and it will not be very surprising if future systems are, to some extent, hampered by regulations which directly arise out of such unfortunate mishaps.

WE may take regulation 2 of the new rules as affording some indication that the Board of Trade is disposed to look more favourably upon house transforming apparatus than it has hitherto done. It is a crumb of comfort which may assuage the anxiety caused by other rules of a less reassuring nature. We are not disposed to quarrel with rule No. 4 which sets forth the maximum amount of current that may be put through a single main, but obviously this depends whether the rule will apply to all existing works. If that were the case it might involve some hardship and we are not surprised that it has met with considerable condemnation. This rule has clearly arisen out of the City accident, when it will be remembered the main which caused the catastrophe was carrying an abnormal amount of energy. It is claimed that Rule No. 6, which necessitates, with transforming apparatus, a suitable means of protecting the low pressure system, puts a distinct disability upon electrical engineers in that there is no very reliable means of protecting the secondary of a transformer from leakage from the primary. The draft rules are not all models of perspicuity, but it is difficult to know how much is due to the vagaries of printers and how little to the personality of the Board of Trade's draftsman. To take two or three rules at random, we should imagine that Nos. 9, 32, and 36, would provide ground for interminable arguments. If no criticism were advanced at all it is self-evident that the draft rules want very careful reading, indeed so badly have they suffered in the process of printing and editing, that we think that a second set of rules freed from clerical errors ought to be submitted to the electrical profession.

IN some respects we distinctly dislike the attitude taken up by the Board of Trade. We are inclined to think, perhaps wrongly, that they are endeavouring to exceed the powers, great as they are, that have been invested in them. Rule 47 sets forth that all arc lamps shall be so guarded as to prevent pieces of ignited carbon or broken glass falling from them, and that they shall not be used in situations where there is *any danger of the presence of explosive dust or gas*. Obviously such conditions could only be set up in the interior of buildings, and is it to be contended for a moment that the Board can suggest to a private person in what place or in what manner he may set up an arc lamp? If a man chooses to place an arc lamp in dangerous surroundings unless the safety of others be threatened, we cannot see what the Board of Trade have to do with it. Of course we may be taking a wrong view of clause 47; probably it is meant to apply only to undertakers, but then there are few places controlled by supply companies "where there is danger of the presence of explosive dust or gas." If the clause is meant to affect the consumer, we think that the Board of Trade are travelling outside their sphere of influence; indeed, it must not be forgotten that the very regulations which we have been discussing are to be applied solely to the suppliers of electrical energy. We do not want to propound anything in the nature of conundrums, but supposing a consumer on an alternating 100-volt distributing network were to conceive the idea of putting in his house a step-up transformer for the purpose of obtaining a pressure of 2,000 volts; this would be dangerous to life, but who is to prevent the aspirations of such an ambitious consumer?

SOME FIGURES RELATIVE TO THE COST OF PRODUCER GAS.

By W. H. BOOTH.

(*Concluded from page* 702.)

Though our investigations would thus appear to have entirely corroborated our previous contention as to the superiority of the gas engine even when measured solely on the basis of gross fuel consumed without any attempt at economy of waste heat, we have been gradually lead forward to the consideration, first, of the thermal economies possible, and, secondly, of the chemical possibilities in securing bye products of such value as ammonia, exactly as such products are now being saved from the gas produced by blast furnaces. In the one case a fuel destructor is put to work with the primary object of making carbonic oxide gas, and the residuals have been wasted; in the other case—of the blast furnace—the residuals have, of late years, been in many instances saved with great economic advantages, but the gas has gone very much to waste in that it has been very ineffectively used. Why not then in the regular gas producer save and utilise to the best advantage all bye-products, gaseous or liquid, thereby obtaining power for electrical transmission at a minimum of cost? Given the practical feasibility of the combination, and there do not seem to be any good reasons to urge against its entire practicability, the economy of plant would be enormous and of really national advantage. The gas engine as a unit in a power station is a particularly suitable prime mover for divisional treatment, that is, for units of varying sizes, as small gas engines are, relative to large ones, much more economical than small steam engines, the truth being that all gas engines are so shamefully wasteful in the heat they transfer to their water jackets that one engine, small or otherwise, works as well as another, the heat converted to work being so small a part of the heat generated in the cylinder. If the figures given in the report of the Society of Arts motor trials of 1888-9 be examined, they will be found to show that in one case 25·5 per cent. of the calorific value of the gas was converted into work, and 27 per cent. was rejected at the water jacket, nearly 38 per cent. going to the exhaust. With another engine these three percentages were 22·1, 43·2, and 35·5 respectively, part of the heat in this case, it is true, being measured twice over, which cannot well be avoided. In a third case the figures were 20·9 41·1, and 38 per cent. They all show an enormous loss to the water jacket of heat, which, it is rational, so long as this jacket must be employed in making steam for the gas producer. Approximately, then, four-fifths of the potential heat that exists in the gases is available for regenerative purposes, or, at least, three-fourths, leaving about a fourth for performance of work, that is, one-fourth of two-thirds the fuel, being 16 per cent. approximately of the total fuel. From this 16 per cent. of fuel the result is, as seen, about equivalent to a consumption of 1½ lbs. of coal per horse-power hour, and it is from the remaining 84 per cent. that further economy is to be sought in addition to the chemical economies indicated. Speaking of the manufacture of sulphate of ammonia, Newbigging and others, refer to the process as exceedingly easy and simple, and consider that 1 ton of coal will yield 28 lbs. of sulphate when the coal is carbonised in the retort without combustion of the coke.

This is a result obtained in ordinary gas works' practice upon which Mr. Mond would appear to show that there is considerable improvement to be effected as regards gas producers.

Where the separation of the tar oils from the pitch is not desirable, the value of the crude tar produced from 1 ton of coal is about equal to one-eighth of a ton of coal if the value be based on the results obtained by Mr. Holden with his locomotives on the Great Eastern Railway. The certainty of a steady supply of tar for locomotive use would undoubtedly tend to an increase in liquid-fuel-burning engines, for use in which, tar, at 1d. per gallon, is equal to coal at 8s. per ton. The crude tar is thus apparently worth quite 1s., so that the figures advanced may be regarded as exceedingly moderate. Enough, however, has been advanced to show the direction in which the use of fuel is gradually tending, and how hopeful the prospect is for the gas engine if such a scheme could be set going.

It has been urged by a writer in the *Engineer* that the gas engine labours under the disadvantage of being a costly machine in up-keep, that its wear and tear is great, and the shocks to which it is liable are so severe that it is very soon reduced to a bad condition. Undoubtedly many of the earlier gas engines were far from well built, and even the Crossley engine, with its objectionable slide valve, was very unsatisfactory in its working; but slide valves have given place to ignition tubes, which are most durable, and a modern gas engine by no means shows those signs of distress that are charged to it. The writer has had one working nearly 2 years without a sign of trouble. It is a matter of common knowledge that the single acting steam engine owes its success very largely to the fact that double-acting steam engines of ordinary proportions failed when run at high reciprocating speeds, for they were not suited to such speeds, either in proportions or in their system of lubrication. But the failure was one of design only, and design has overcome the trouble, and so it must be with the gas engine, the proportions and oiling of which are developing to suit the conditions under which they have to work.

For varying loads such as those of an electric light station, the gas engine is undoubtedly far superior to the steam engine. Small gas engines give a highly satisfactory thermodynamic result, and a gas motor plant made up of graduated integers of power should be an ideal plant, the increase of demand for light being met by the addition of one integer after another and the falling off of load being unaccompanied by any loss of the kind inseparable from steam boilers.

In any electric station the starting difficulty need have no place. A series of gas engines can be started by temporarily driving them from a slowly revolving shaft, or by the temporary conversion of each dynamo into a motor to start its own engine.

The annexed diagrams will render more clear (*a*) the distribution of heat in a gas generator plant and (*b*) the distribution of the cost of the original coal, while diagram (*c*) shows the process of regeneration on the basis of an assumed recovery of one-half the heat lost at each point. Could diagram (*c*) be realised in conjunction with diagram (*b*), the net fuel per horse-power would not exceed 4 ounces per hour in cost, or 8 ounces by weight.

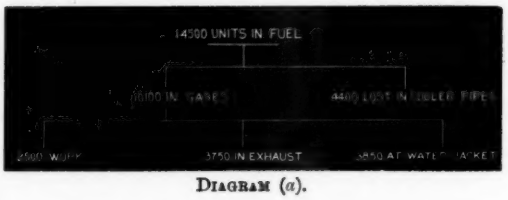


Diagram (*a*).

Diagram (*b*).

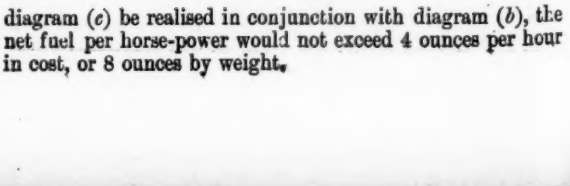


Diagram (*c*).

THE INCANDESCENCE LAMP.*

By A. BAINVILLE.

(*Continued from page* 441.)

The description that we have concluded shows us how complicated and full of detail are the various operations necessary to the production of an incandescence lamp, and fully justifies what we said at the beginning of it.

As it was not our intention to write a complete treatise on the manufacture of the lamp, we have been obliged to pass over in silence a number of details which would only be interesting to the maker; we hope, however, that our description will give a sufficiently clear idea of this delicate and special industry.

To complete the programme that we sketched out at the beginning of this series of articles, we must now discuss the practical working of the lamp that has been constructed. We propose, in particular, to indicate the practical conditions of employment of the incandescence lamp, and to enumerate and discuss the various causes of deterioration that are introduced by careless usage; we shall thus make a distinction between the normal causes of destruction and those which are brought about by the conditions in which they are placed; we will discuss this point somewhat fully, as we wish to protest against certain usages fatal to the duration of the lamps, and indirectly to electric lighting itself, usages which cannot always be justified.

The Practical Conditions of the Employment of Incandescence Lamps, or of the Choice of the Lamp, suited to each particular case.

At the present day we find in the market incandescence lamps, the initial consumption of which varies between 2 and 4 watts per candle-power. Each of these types of lamp answers to some special application, *i.e.*, in some special case it gives the best possible results; it is not, therefore, advantageous to use them indiscriminately. The indications given by the maker as to the consumption of energy cannot, as we have already seen, be looked upon as absolute. The quantity of light supplied by a given lamp being closely connected with the temperature to which its filament is brought, we can really make its luminous efficiency vary within fairly wide limits by increasing or diminishing the amount of electrical energy supplied to it. In practice, however, notwithstanding this elasticity of working, it is generally disadvantageous, from an economical point of view, to depart from the data supplied by the maker. This is owing to various causes, amongst which, the imperfection of the lamps themselves plays a considerable part. All the lamps of one make do not act in the same way; in other words, the relation connecting the luminous power with the consumption of energy is different according to the lamp considered. This explains the different formulæ proposed up to the present, none of which are applicable to all cases. The degree of perfection of the vacuum certainly plays a considerable part, and besides, as the nature of the filament, *i.e.*, its emissivity varies continually and arbitrarily all through the time the lamp lasts, the formula that might be correct at the beginning, would certainly not be applicable after the lamp had been in use a certain time. And, again, we have not mentioned the disintegration of the filament, which varies according to the make of the lamp, and which modifies the electrical resistance, nor the blackening of the bulb, which occurs more or less rapidly.

Other considerations, of an exclusively practical order, also help to reduce the elasticity of working of the lamp. Thus the platinum wire supporting the filament becomes insufficient if the current is increased to any extent; the same may be said of the joints, which may then be brought to red heat, and of the bulb itself, the volume of which should be in proportion to the consumption of energy of the lamp.

These various causes are, as we see, quite sufficient to confirm what we have already said as to the employment of lamps of various consumptions; we will now see in what particular case each type of lamp should be employed.

If we consider the question from a purely economical point of view, and suppose that the current supplied to the lamps is always perfectly regular in most cases, it will be to our advantage to use lamps with a high luminous efficiency. This is clearly shown in the following table, in which the sum of 1·50 fr. has been admitted for the calculation of the sinking fund, and durations of 150 hours for 2-watt lamps, 300 hours for those of 2·5 watts, 600 hours for those of 3 watts, 800 hours for those of 3·5 watts, and 1,000 hours for those of 4 watts. The table gives in centimes the cost per hour of the lighting in four different cases of the price of electrical energy.

Price of the kilowatt	0·15 fr.		0·30 fr.		0·60 fr.		1·20 fr.	
Luminous power in candles ...	10	16	10	16	10	16	10	16
Types of watt lamps per candle.								
2	1·300	1·48	1·6	1·96	2·2	2 92	3·40	4 84
2·5	·875	1·10	1·250	1·7	2 00	2 90	3·50	5·30
3	·70	·97	1·15	1·69	2·05	3·13	3·85	6 01
3·5	·715	1·03	1·24	1·87	2·29	3·55	4·39	6 91
4	·70	1·06	1·30	2 02	2·50	3·94	4·90	7·78

The 2-watt lamp which is indicated in the case where the electrical energy costs most, is unfortunately of a construction unsuited to low luminous powers, and, moreover, its short duration would necessitate the occasional employment of a workman to effect the substitution, which would considerably increase the cost of the lighting.

Lastly, lamps of this type show, up to the present, great differences as to duration, and thus do not ensure sufficient regularity in the lighting, so that it is better to reject them, even if the current is absolutely regular. We are only speaking here of the lamps in general use, for those of great luminous power, this type may give good results.

The 2·5-watt lamp is not often made of less than 16 candle-power, and it only gives good results on condition that the current is very regular for low luminous powers at least.

The type of 3 watts per candle constitutes the practical lamp for small consumptions. It is capable of bearing slight variations of current without being at once rendered useless, like the two above-mentioned types; and its mean duration renders its employment really practicable in all cases where the current is regular.

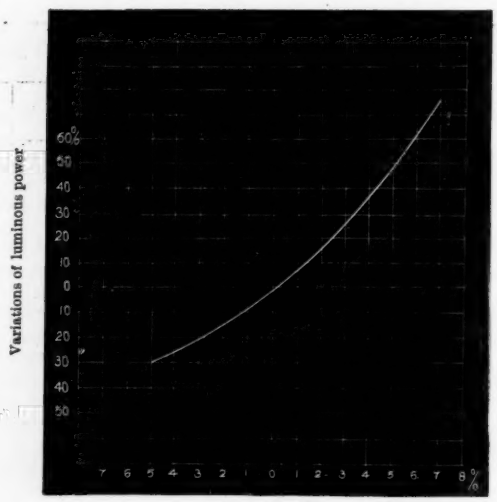
With lamps of 3·5 and 4 watts we arrive at the types most generally used. These lamps are strong, for they are, as a rule, capable of supporting such an increase of current that their consumption per candle is reduced to 2 watts; they cannot, however, be subjected to such variations with impunity; their duration is considerably reduced thereby.

In short, if the incandescence lamp only works really well when the electrical energy is supplied to it under a constant difference of potential, the lamps of low efficiency will nevertheless be able to bear the variations, amounting even to 15 per cent., to be observed in certain large installations in towns; but we must not think of employing types of 2 to 3 watts per candle under such conditions, as the duration of the lamps would be simply ridiculous, and the reliability of the lighting altogether insufficient. Even if we disregard the cost of the lighting, the employment of low consumption lamps should still be deprecated on account of the irregularity of the light resulting from such variations. On the other hand, in all cases where the current is very regular, we should employ the low consumption lamp (the 3-watt type in particular). This is one of the conditions of good economical efficiency. If, for instance, the lamps are placed on a circuit fed by accumulators, the employment of the lamp with high efficiency enables us to realise a double saving both on the cost of first establishment and on the daily consumption.

There is another point of real practical importance when the choice of a lamp is in question; that is the colour of the light furnished; this light is whiter in proportion as the consumption of the lamp per unit of light is lower, and this can easily be conceived, since the temperature to which the filament is brought increases in proportion as the consumption decreases. The proportion of red rays therefore becomes less and less, thus approaching the composition of white

* *L'Electricien.*

light; but, at the same time, as in the light emitted by the arc, the spectrum of emission for temperatures corresponding to consumptions of 2 to 3 watts extends considerably on the side of the chemical rays, so that the colour of the light emitted by these lamps takes more and more of a violet tinge. We also observe in lamps with very low consumption a peculiar effect that strikes the eye in addition to the colouring of the light emitted by the filament which is already slightly tinged with violet. This is a sort of fluorescence in the



Variations of voltage.

Fig. 13.

crystal of the bulb; this fluorescence is of a blue violet tint, and somewhat similar to that which ordinary crystal takes when being blown. This phenomenon is perhaps due to a defect in the transparency of the glass; it is moreover more marked when, all other conditions being equal, the bulb is of smaller dimensions. Therefore, when we wish to obtain a yellowish light similar to that of gas, we must not choose lamps of high efficiency.

It is very certain that in an important electric lighting installation several different cases will present themselves, so that we may be led to use lamps of different consumption; as a rule, however, we may content ourselves with a single type, especially when the various circuits are supplied by a dynamo driven by a special engine, *i.e.*, when the current can be kept very regular. In this case, in short, the lamp with high efficiency will be suitable in all places where a brilliant light is required; as after 300 or 500 hours of service, according to the type, these lamps have lost much of their luminous power, without their filaments being broken, they can still be employed with advantage at all points where a less brilliant light is sufficient, or even where a reddish light is desirable. Nevertheless, if the lighting is supplied partly by a very regular current (accumulators, for instance), and partly by an irregular current (dynamo worked by an engine with variable load), as is the case in many works, we must not hesitate to use the two types indicated for the two respective cases. The curve in fig. 13 shows the variation of the luminous power as a function of the variations in the difference of potential at the terminals for a given lamp; we have already said that this curve varies according to the lamp; it takes, however, generally much the same form. The examination of this curve shows how rapidly the luminous power increases for slight increase in the voltage, and consequently how important it is in all cases, from the point of view of the duration of the lamp, to keep this voltage constant.

The durations that we have attributed to lamps of different consumption are to all intents those during which lamps of good make, working normally, keep up within a little their initial efficiency. The actual duration of the lamp may be much greater, but from an economical point of view it is better to replace it at the end of this period.

(To be continued.)

THE MAXIMUM POSSIBLE EFFICIENCY OF GALVANIC BATTERIES.*

By HENRY MORTON, Ph.D.

Some recent publications and other intimations indicate that, with the general revival of business, there are likely to be brought before the public various schemes, such as some of those discussed in the writer's recent articles on "Engineering Fallacies," in this magazine, in which electric energy, derived from galvanic batteries, will be relied upon as the source of power. In view of this, it would seem as if a few words on the above subject might be timely, and the writer has therefore ventured to put into shape the appended calculations.

To discuss this question in an exact and numerical manner, it will be necessary to indicate with precision what class of batteries are referred to, and the writer would, therefore, say at the outset that he refers only to those which long experience has proved to be the most efficient in supplying large currents, excluding those of the Leclanché type which yield only feeble currents.

In all the batteries here referred to, there are the following common features:—1st: The energy is derived from the combination of zinc with dilute sulphuric acid. 2nd: The supply of oxygen required for this combination is obtained by the decomposition of water or some other compound in aqueous solution. In other words, the batteries here considered are the Smee, the Daniell, the Grove and the various forms in which chromic acid is the oxygen-supplying substance.

This being premised we can begin with the following general statement of principles:—First. The source of energy being the reaction between the metallic zinc and the dilute acid, its amount can be expressed in British thermal units as follows:—Oxidation of zinc, 2,340 B.T.U.; solution of oxide in dilute sulphuric acid, 666 B.T.U.; or, in all, 3,006 B.T.U. as the total energy developed by the union of the zinc and acid. No arrangement of parts or employment of one material or another in other parts of the cell or for other parts of the reaction can add anything to this, but on the other hand there must always be more or less subtracted from it to meet the demands of the reaction, to say nothing of internal resistance of the solutions, local action, &c.

Second. In order that the zinc should combine with the acid, the hydrogen, whose place it takes, must be driven out or otherwise taken care of, and this will demand an expenditure of energy, greater or less, but always considerable. For example, in the Smee battery the hydrogen is simply driven out in bubbles of gas. To do this requires 2,106 B.T.U. for each pound of zinc dissolved. Taking this from 3,006, leaves only 900 B.T.U. as even possibly available from each pound of zinc consumed in a Smee battery, not counting losses coming from local action, resistance, &c.

This difficulty was realised at an early period and was met by supplying oxygen to take up the hydrogen, and so avoid the great loss involved in expelling it. To supply this oxygen, various substances have been used, but the only ones of practical importance are sulphate of copper, nitric acid and chromic acid. But even with these, more or less energy must be expended in decomposing them and securing their oxygen. The energies involved are:—

	B. T. U.
Sulphate of copper, Daniell battery... ...	1,587
Nitric acid, Grove or Bunsen battery ...	283·6
Chromic acid, Poggendorff battery	178·5

If these various amounts are subtracted from the maximum thermal value of the zinc-in-sulphuric-acid combination, we will have for the several batteries:—

	B. T. U.
Smee battery, as before	900
Daniell battery...	1,419
Grove or Bunsen battery	2,722·4
Poggendorff (chromic acid)	2,827·5

These figures represent the absolute maxima of energy which a pound of zinc could develop in these forms of battery, excluding all losses from resistance, &c. To get a practical view of these results, however, it will be necessary to reduce them to equivalent foot-pounds of work and to horse-power rates of doing work.

* *Cassier's Magazine.*

Joule has shown that each British thermal unit is equal to 772 foot-pounds, and this means that the energy expressed by the heat which will raise 1 lb. of water 1° Fahrenheit (this is the British thermal unit) would lift 1 lb. 772 feet, or 772 lbs. 1 foot. If, then, we multiply the figures given above, we shall have the various energies expressed in foot-pounds of work. In other words, a pound of zinc, consumed in these various batteries, would develop the following numbers of foot-pounds, all losses from resistance, &c., being excluded :—

	Foot-pounds.
Smee battery...	694,800
Daniell battery	1,095,468
Grove battery	2,101,694
Poggendorff battery	2,182,820

If, in each of these batteries, 1 lb. of zinc were consumed in a minute, then the above numbers of foot pounds would represent the work developed in a minute in each case, and to turn this into horse-power we should divide each number by 33,000, because a horse power is a rate of doing work of 33,000 foot-pounds each minute. This will give us the horse-power represented by the solution of 1 lb. of zinc each minute in each battery.

Smee battery	21·05 H.P. for one minute.
Daniell battery	33·19 " " "
Grove battery	63·66 " " "
Poggendorff battery ...	68·57 " " "

Such a rate of consuming zinc as a pound a minute would, of course, require an immense galvanic battery, and indeed it is usual to express the consumption of fuels generally in pounds per hour. To get the horse-power due to the consumption of zinc at the rate of a pound an hour, we divide the above figures by 60, and this gives the horse-power developed by a pound of zinc consumed during an hour as follows :—

Smee battery	0·35, or about	⅓ H.P.
Daniell battery	0·55 "	½ "
Grove battery	1·06 "	1 "
Poggendorff battery	1·14 "	1¼ "

This shows that in the best forms of battery an allowance of one horse-power for each pound of zinc consumed per hour would be a liberal one, if something is allowed, as it must be, for the resistance, local action, &c. It may, however, be asked: If such an improvement has been made as above shown from the Smee battery giving one-third to the Poggendorff yielding 1¼ horse-power, may we not expect further improvements as great in amount? To this I answer certainly not in this class of batteries. The entire energy of the reaction between the zinc and dilute acid is 3,006 British thermal units. This would represent 2,320,632 foot-pounds, or 70·62 horse-power for one minute, or 1·17, say 1⅛, horse-power for one hour, and this would be an absolute maximum which could never be reached, far less exceeded.

Of course, if we could use some other, and more efficient, reaction than that between zinc and sulphuric acid, some gain might be secured, but nothing of that sort has ever been accomplished, nor from what is known of the combining or thermal equivalents of the available elements, is much to be expected in that line. At all events, we may well accept this as a certain fact, that in any known form of galvanic battery the round figure of a pound of zinc per horse-power per hour is an outside figure for efficiency, and when anyone asserts that more than this has been secured, there is certainly some mistake or fraud.

DUBLIN ELECTRIC TRAMWAYS.

The report which Mr. Robert Hammond has presented to the Dublin United Tramways Company with relation to its proposed adoption of electric traction is handsomely printed, and accompanied by a very complete set of illustrations of the South Staffordshire electric tramway and other views, showing trolley wires suspended from double bracket arm centre poles located between tramway tracks.

Mr. Hammond is apparently quite convinced that electricity is the only economically available motive power which can be adapted to the company's needs; that the only method of electric distribution that has demonstrated its ability to fulfil the needs of a modern tramway is the trolley system, and that of all trolley wire constructions, that employed at South Staffordshire is the best.

The value of the report would, in our opinion, have been greater had Mr. Hammond availed himself of the co-operation—if need there were of his calling in additional talent—of an engineer not so intimately connected in the public mind with a given system. We have high respect for the ability of Mr. Alfred Dickinson; but it is only natural that the patentee of a given method of trolley wire operation should believe thoroughly therein. As the report stands, Mr. Hammond, with the "co-operation of Mr. Alfred Dickinson," rests his case in great part upon the methods followed, and results attained upon the South Staffordshire line, and apparently leans strongly to the opinion that the success of the system there employed has been so great as to warrant its being followed by the Dublin United Tramways.

We can, therefore, scarcely regard the report as the expression of a wholly unbiassed opinion.

It would seem to us that where the daily service of a great city is in question, more detailed reference might have been made to installations which have stood the test of actual use in great metropolitan centres, and less to the comparatively small plant so largely quoted. The wholly favourable criticism of the local authorities of Walsall, Wednesbury, and Darlaston, is unquestionably most interesting, but opinions from those great cities where hundreds of electric cars have long been in daily operation could not but carry greater conviction.

We are quite prepared to believe it possible that the system of trolley wire suspension employed at South Staffordshire may some day prove itself to be *facile princeps*, but neither Mr. Hammond nor we can afford to pin our faith thereto until it has been in use upon a far greater scale, and under the onerous conditions of heavy and constant passenger traffic. As Mr. Hammond says: "It may, however, be conceded, that no existing line in the United Kingdom is working under conditions that obtain in Dublin." Why not, therefore, go further afield in the search for a more nearly parallel instance?

Mr. Hammond has evidently felt the superlative necessity of meeting the fire-escape objection to overhead wires which has so often been urged. We cannot believe that the British mind is so wedded to fire-escapes of a given pattern and dimension that any change therefrom is hopeless. Certainly the question is not one of such great moment that it should absolutely govern. Buildings in Continental cities are of a much greater average height than in the United Kingdom, and yet the fire departments seem to have easily adapted their appliances to successful operation in streets through which trolley cars travel. This is even more true of American cities, where not only are fires more frequent than in Europe, but trolley lines are frequently carried but 16 feet from the ground, instead of at the minimum height of 21 feet proposed for British lines.

The question of how the trolley wire is to be supported is naturally one of great practical importance, and it must be met in a fair spirit by both local authorities and tramway operators.

Both should have at heart efficiency of service as well as æsthetic considerations, and it would seem to us that the former is the more important. It is our belief that mechanical, and especially electrical, traction, will be widely introduced in Great Britain within the next few years, and that the tramway will shortly become a great and indispensable factor of urban and suburban existence, and subserve the interests of our great working class to an extent exceeding that of any other adjunct to city life. We hope that its progress will not be blocked by absurd restrictions, or by hard and fast rules, allowing no latitude for the necessities of the individual case. Streets are made for the people, and modern conditions are such that the extension of rapid transit facilities is an essential second to no other. If overhead wires be necessary to secure rapid transit (and no other system has yet demonstrated the same or an approximate efficiency) they must be allowed, and if their use be permitted, they should be so placed as to ensure the best results in operation, not arbitrarily disposed at the point considered least obnoxious from an æsthetic standpoint.

Our own belief is that by far the best arrangement is that adopted on many Continental cities where the trolley wire is supported from span wires attached to staples in the walls of abutting buildings. This system is, of course, unavailable where the constructions along the route are old and weak, but wherever it can be employed it certainly facilitates construction, and has very few objectionable features.

Where the tracks can be placed at a sufficient distance apart, centre poles placed on suitable refuges can advantageously be used to support the trolley wires, and are very slightly more conspicuous than the system of arc light supports used in many of our cities. Street lighting and tramway power distribution can easily be combined effectively where this system is employed.

The single bracket-arm pole is, of course, most desirable for single track lines where the metals closely follow one side of the roadway.

Span-wire suspension from poles at either side of a highway is naturally less desirable so far as appearances are concerned, and more costly, than those heretofore mentioned, inasmuch as it requires a double line of poles along the street. The mere wires are no great objection from our point of view, when we consider the value of the result to be obtained. Experience has apparently demonstrated that the best service, economy, and efficiency, are obtained where the trolley wires most closely follow the line of the tracks upon which electric cars run, and that no pains are too great to take to ensure their being so supported. At least, that is the verdict of those American and European engineers who have had in charge the most prominent and successful installations. It is, of course, an engineering and electrical possibility to carry a wire at any point between house fronts, and to make contact therewith by some form of collecting device; but it would seem that efficiency is sacrificed in proportion to the horizontal distance between the centre of the trolley bearing and the line of conductor.

The most interesting matter in Mr. Hammond's report is the copy of a letter from the Law, Accident and Contingency Insurance Society, stating that while the South Staffordshire Electric Tramways originally paid the same rates for insurance against "Third Party Risks" as a steam tramway, their immunity from accident has been so great, that the premium paid is now less than half that paid by steam tramways.

We are, on the whole, distinctly disappointed in Mr. Hammond's report. It is not the careful presentation of established data applied to a given case which we would have liked to see. There is ample material at hand to make possible a judicial examination and thorough comparison of various types of plant, methods of installation, and economic results. The generalities of the report are of little or no value to anyone interested in traction.

WHAT ELECTRO-THERAPISTS SAY.

We have received two pamphlets, one entitled "Apologia pro Electricitate Sua," by Dr. W. S. Hedley, of Brighton, England, and the other called "Electricity in Medicine from a Modern Standpoint," by Dr. Wm. J. Morton, of New York City. Both are well worth reading. The authors are men of repute in the medical profession in their respective countries, and their writings on matters electro-medical are not unknown in these columns. The communications show undesigned coincidence on several points. Dr. Hedley's "Apologia" appeared in the *Lancet* of May 4th, and Dr. Morton's contribution was published in the New York *Medical Journal* of the same date, so that we have the opinions of two experts expressed independently, one in the Old World and the other in the New, at practically one and the same time.

It is a source of great satisfaction to us that the keynote of each is the very point that the Electrical Review has so persistently advocated for years past, viz., the paramount importance of electro-physics as a part of electro-therapeutics. Dr. Hedley says "the physical problem underlies the biological one, and it is of vital moment to know something of the nature of the energy they employ," and "another work of progress appears in the fact that physiologists begin to recognise that chemical and electrical processes are inseparable from those that have hitherto been called vital, and that electromotive force is very constantly the outcome of physiological action. There are signs that physics begins to 'encroach on the domain of physiology, and that medical men are more and more turning their attention to physics' (quoting the words of D'Arsonval). What has been called physical biology, or biological physics, seems already beginning to differentiate itself, and to stand out as a special branch of science. It forms a kind of neutral ground, where medical and electrical science find a common holding point and a common end. To the medical man his line is clear. With the lessons of experience well in view, he takes his stand upon the broad principles of electro-physics, and the known action of electrical currents on vital structures." Dr. Morton says: "How, then, shall the physician keep pace with these strides in such a manner that medical science shall not suffer? Obviously by but one method, that of informing himself as to the fundamental laws of electricity, and their applications in practice. To do the first he must study electro-physics, and to study this, he must turn to the work of the electrical engineer. The two branches to a certain extend blend."

In considering how the body is electrically influenced, the "Apologia" reads "applying this to that very imperfect conductor, the human body, it is evident that the latter may be regarded as an appliance capable of utilising in a variety of ways energy transmitted by the ether," while the American author writes:—"The broadest one (principle) I am able to formulate, and which I would, in fact, suggest for a *definition of electro-therapeutics*, in a biological sense, is that electric energy applied to the vital energy of living organisms undergoes a transformation into the energies characteristic of such organisms; the energy termed vital is modified by the energy known as electrical—it is a question of electrical *versus* biological energy. Of the vital energy, we may say that its beginnings are life, its normal progress is health, its perversions are disease, its cessation is death. At some point in this gradient, either as a somatic aggregate or as a cellular unit, the applied electrical energy of electro-therapeutics is transformed into some form of vital energy, namely, transformed into some function of protoplasm and its modifications."

Dr. Hedley argues that electricity in medicine "has suffered by the activity of impostors, by the prejudices of its enemies, by the intemperate advocacy of its friends, and, perhaps, more than all, by the crude empiricisms of its methods," and "medicine cannot reasonably cultivate an attitude of aloofness towards an agent to which it owes so much as it does to electricity. . . . To test the claims of electrical treatment, it must be judged by the same standards that apply to the rest of medicine. What conditions is an accredited therapeutic agent expected to fulfil, and in which of these has electricity been tried and found wanting?" He then goes on to give various reasons and state facts in a carefully thought out manner, which ought to prove convincing to any thinking man. The most hardened sceptic cannot fail to admit that Dr. Hedley is not guilty of "intemperate advocacy," and that if his apology errs at all, it errs on the side of caution.

Dr. Morton takes a bolder tone, evidently not finding it necessary to write an apology in New York. He discusses the present position of electricity in medicine in a decided and practical manner, which must impress both the student and the practitioner. He bases his conclusions on sound science, reason, and wide practical experience, and therefore speaks with no uncertain voice. Of the strictly *modern* methods, metallic electrolysis is shown to be one of the most successful and promising. Quite a long list of diseases is given, which, the author says, "I have also treated in this manner, and with a success unattainable by other methods."

We have referred to the resemblance of these two publications, and now a word as to the difference between them. Though both addressed to medical men, the English one is an apology for the existence of scientific truths, professionally slighted and neglected; the other is a *bold statement* of work done and advance made in the practical working of these same truths, professionally accepted. What a comment on the conservatism (or shall we say obstruction) of the medical profession in England!

BUCKLAND'S IMPROVED PLATE FOR SECONDARY VOLTAIC BATTERIES.

In our issue of April 26th, 1895, we published a report made by Mr. H. Cuthbert Hall on a secondary battery, together with some editorial comments, which, as we announced in the succeeding issue, had the effect of causing a writ for libel to be issued against us. We have received another copy of Mr. Hall's report identical with that we published except that the copy just to hand is headed: "Tests of the Buckland battery," and for the letters I.S. (International Storage) in the text the word "Buckland" is substituted. Below we give a description from the complete specification issued last week, of the only Buckland secondary battery plate we have been able to find.

This invention relates to the construction of a plate for secondary voltaic batteries in such a manner that the active material is held in position on the plate without exposing any of the plate to the action of the electrolyte.

Fig. 1 is a front view of the bare plate as it is cast, fig. 2 is a front view and fig. 3 is a vertical section of it as prepared to receive the active material.

Fig. 4 is a vertical section of the plate charged with the active material.

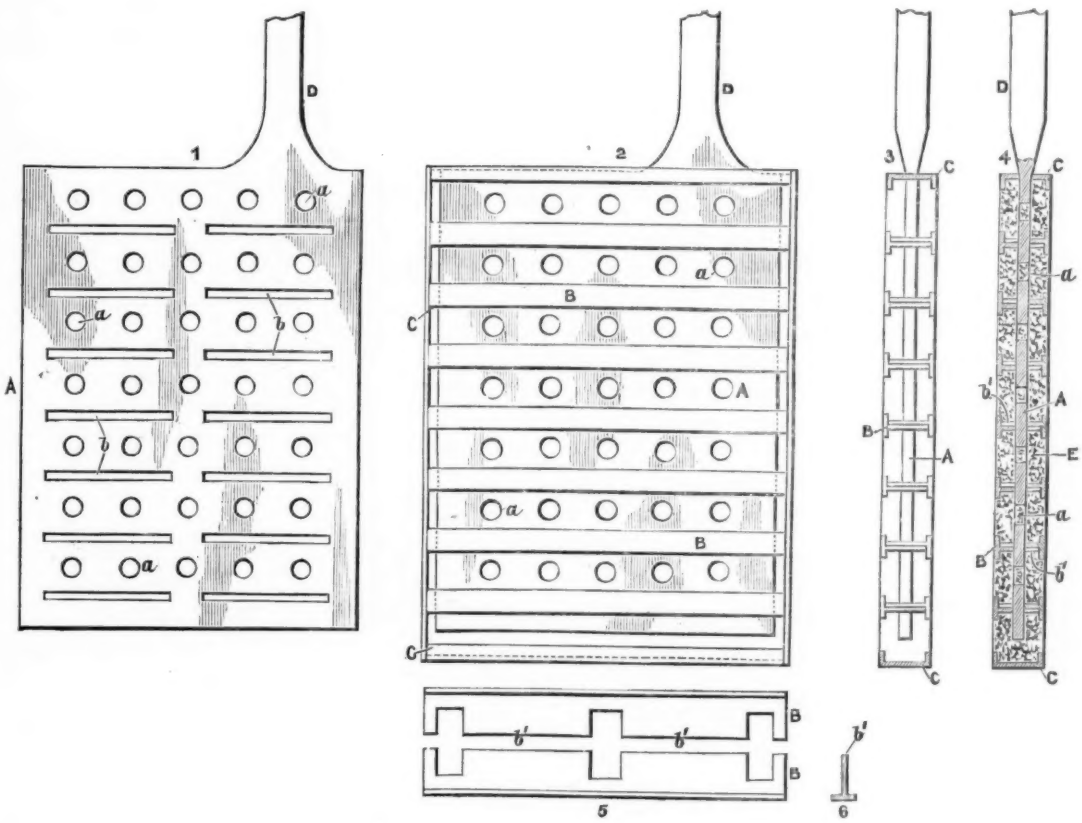


Fig. 5 is a plan of a pair of the partitions, and fig. 6 is a section of one of them.

The inventor casts a plate, A, fig. 1, preferably of an alloy of lead and antimony, a number of slots, *b*, and holes, *a*, being formed either in casting the plate or being afterwards punched through it. He takes a number of pieces, B, of some substance such as celluloid, ebonite, or the like, which is not attacked by the electrolyte employed in the battery, and which has certain elasticity, and cuts these pieces as shown in fig. 5, so that their projecting parts, b^1, can be inserted from opposite sides of the plate into the slots, *b*, and held therein by cementing the piece inserted from the one side on to the piece inserted from the other side. He also provides a frame, C, of celluloid or like material completely surrounding the plate, A, except where its conducting limb, D, passes up through the frame. Having thus provided on both sides of the plate a number of compartments separated by the partitions, B, and terminated by the sides of the frame, C, he charges these with active material, E, the layers of which on the one side communicate with those on the other side through the holes, *a*.

The single claim in this patent reads as follows:—

A plate for a secondary voltaic battery presenting on both of its sides compartments separated by partitions and surrounded by a framing of celluloid or equivalent material, these compartments being charged with active material communicating through holes in the plate, substantially as described.

OKONITE.

The reputation which this insulating material has obtained is not of the very highest, not so much, perhaps, on account of any inherent bad qualities which it possesses, but rather on account of the use which has been made of it for the purposes of financial speculation of a not particularly healthy order. Of the latter, however, we do not purpose now to allude. We have before us a report by Dr. J. A. Fleming, which practically purports to give an exhaustive series of tests, which show up much to the advantage of the substance. Now, we do not suggest either that okonite is a bad material for insulating purposes, or that Dr. Fleming's report is not intended to be a fair one, so far as the lights of the reporter go, but we do hold that at the same time it is utterly insufficient to prove what it is intended to do. Dr. Fleming places the wire insulated with okonite in water for a few days, and tests it with 200 volts (which is certainly not an excessive power), and finds that an insulation resistance of several thousand megohms per mile is obtained, and, further, that good electrification is noticeable. This so far is all right. He further submits the material to the strain of an alternating voltage equal to 7,000 volts pressure for *three minutes*; which test the material stood perfectly, as, indeed, many

other materials *will*, and others which have been brought out with a flourish of trumpets (and which are practically unheard of now) *would*. As an example of those that *will*, we have had some tests made for us on some cables of the British Insulated Wire Company's manufacture. The mean diameter of the conductor was ·59 of an inch, the radial thickness of insulation ·073 of an inch. It will be observed that not only is the conductor larger, but the radial depth of insulating material is less than in the okonite samples tested by Dr. Fleming, which makes the test more severe. Yet the mean of six tests gave a breaking down pressure of 20,500 volts alternating mean value, the current being obtained from a Mordey machine, whereas the okonite broke down at about 13,000 volts. Moreover these cables were not specially made for us, but were manufactured for low tension 100-volt work.

A report on okonite or other cable which may come into the market does not seem to us complete without such an ordeal as that specified by Mr. Preece, viz., a dry heat test and a moist heat test. This we think would give a very fair indication of the probable life of such a compound. The dipping of the cables into a particular acid or alkali shows nothing as to the life of the material, for it is most unlikely that wires would be subjected to such treatment in actual practice.

Presumably the pressure test was applied, so that it was simply run up from zero to a maximum, but a cable which will stand such a test for a minute or two, will, of course, frequently break down if the pressure is applied for a longer time.

A *three* minutes' test is certainly not a sufficient one to thoroughly try the value of a material which has not had the test of time to prove its value; for example, had gutta percha been an insulator which was just being boomed, we should not consider that a test such as Dr. Fleming made a proof of its durability; it would simply prove that the material *at the time it was tested* was perfectly sound, and it would prove nothing more. But even allowing that the test was of very considerable value, we must say that we are unable to see how tests made of material in water can possibly prove as Dr. Fleming says: that "Okonite cable is a very excellent and high class cable for all *outdoor*, *overhead*, or underground electrical work." A gutta-percha cable will stand equally with okonite all Dr. Fleming's electrical tests, but it certainly does not form "an excellent cable for outdoor and overhead work." Again, the mechanical tests to which the okonite insulated wire was subjected prove nothing, the report says: "I bent and kinked several samples at such sharp angles as to break the copper strand inside the okonite insulation," but not a word is said as to what the result of this treatment was, *i.e.*, whether the wire was afterwards tested in water, and found to be good, for it is merely a special mixture of rubber, and if the mixture is a good one it should have nearly the same advantages and disadvantages as a good rubber cable.

We do not, as we before said, condemn okonite as bad, but we hold that the case is one of "not proven" for the all important "time" test for durability, for which there is, unfortunately, no brief substitute, is wanting. Gutta-percha and India-rubber as now manufactured are trusted, not because they stand a few brief electrical tests, but because they have again and again come out victorious under the all important "time" test. The okonite tested by Dr. Fleming may be a specially good mixture, but from our knowledge of American rubber manufacture we should not be inclined to believe this, their general experience being confined to low quality.

SINGLE-PHASE ALTERNATE CURRENT MOTORS.*

By A. C. EBORALL.

(*Continued from page* 723.)

II.—ALTERNATING MAGNETIC FIELD MOTORS.

THIS class of single-phase motor may be conveniently subdivided into

(*a*) Motors whose rotating part is in electrical connection with the supply mains, and

(*b*) Motors whose rotating part is quite distinct from the supply mains.

II. (*a*)—MOTORS WHOSE ROTATING PART IS IN ELECTRICAL CONNECTION WITH THE SUPPLY MAINS.

Owing to the fact that the direction of rotation of any ordinary direct current motor is the same, irrespective of the direction of the current supplied to it, early attempts were made to adapt it for use with an alterating current, by laminating its field magnets. But this is not enough in itself, the crude form having many serious faults, the chief of them being—

1. The hysteresis and eddy current loss may be very large.
2. The motor takes a large current when running light, or underloaded.
3. A large amount of magnetic leakage is generally present, more marked as the motor increases in size.
4. A transformer action may take place between different layers of field magnet winding.
5. As each section of the armature is short-circuited in turn by the brushes, this short-circuited section becomes the seat of very heavy induced currents, which react on the field magnet, and also waste energy in heating the sections, and produce heavy sparking at the commutator.
6. In the series motor, owing to the large amount of self-induction of the field magnet, sufficient current cannot get through, the impedance being so great; and in the case of the shunt motor, it is found that besides the difficulty of getting sufficient current through the field magnet circuit, great differences of phase occur between field magnet and armature currents, and in consequence the maximum magnetic effects in armature and field magnet occur at different intervals of time, and are therefore not coincident, and hence only a small torque is exerted. The motor thus becomes very heavy in proportion to its output.

All these troubles are greatly lessened by lowering the frequency of the supply current. It is easy to show that the output of a motor of this description is a maximum when the E.M.F. of self-induction is equal to the back E.M.F. generated by the motor. But it is only at quite low frequencies that such a condition can be attained at a reasonable speed. Hence it is apparent that the lower the frequency the more efficient does the motor become. One of the great reasons for Prof. Forbes choosing such a low frequency as 25 periods per second for the Niagara transmission was that motors of this type should be enabled to work well.

I will now consider the attempts that have been made to do away with, or to minimise, the causes of inefficiency in this type of motor as enumerated above.

Mr. Mordey proposed to work such motors by means of commuted currents. This is shown in fig. 2, representing a series motor on his plan. The armature, wound either as a ring or drum, is provided

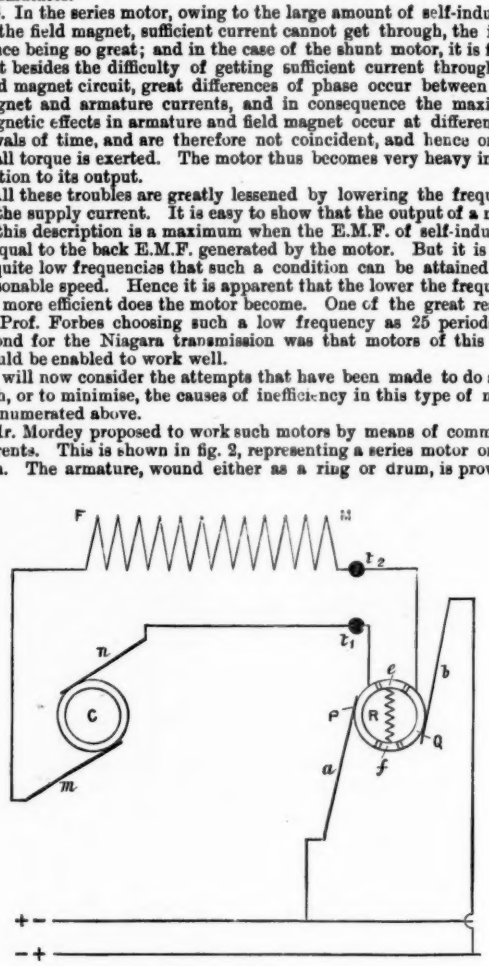


FIG. 2.

with the usual commutator, C, whose brushes, m and n, are connected respectively to one motor terminal, t_1, and to one end of the laminated field magnet, F M, the other end of this latter going to the second motor terminal, t_2. On the shaft of the motor is a second commutator, here shown with but two segments, P and Q. A pair of brushes, a and b, press on this auxiliary commutator, which in turn are in connection with the supply mains. The segments, P and Q, are connected to the terminals, t_1 and t_2, of the motor, by means of rubbing contacts not here shown. On switching the whole arrangement into connection with the alternate current supply mains, the motor starts from a state of rest, the armature and fields being supplied with an alternate current only. But as the speed increases (as it will do until synchronism is attained), the action of the commutator gradually reduces the alternations until the motor is traversed by a direct current. This would occur with a two-part commutator when the alternations of the supply current correspond in rate with the revolutions of the shaft, and with multiple commutators in a proportionate ratio.

The tendency of the motor to increase its speed until this condition of synchronism is attained is due to the fact that the more the rate of alternation of the supply current is reduced, the more powerful does the motor action become.

* Read at a Student's Meeting, Institution of Electrical Engineers, May 3rd.

When the above condition of synchronous action is reached, a very nearly constant speed is the result at all loads within the motor's range of work. Any excess of speed is checked by a loss of power due to the alternations setting up inductive reactions, while any diminution of speed within its range of work is counteracted by the inherent tendency of the arrangement to endeavour to attain synchronism.

Between the segments, P and Q, of the commutator may be placed two smaller segments, *e*, *f*, which are connected to the ends of a resistance or impedance, R. This prevents short-circuiting of the mains by brushes, *a*, *b*, at one particular instant, and diminishes sparking by preventing the entire opening of the circuit.

This motor would have a better speed regulation than a direct current motor, and would be, for the most part, free from the troubles common to this type of motor, except, perhaps, those of sparking, and the large current taken when running light or underloaded.

The principle of the above motor has been utilised by Messrs. Ganz, and by Messrs. Hutin & Leblanc, and by Messrs. Brown, Boveri & Co.

In Mr. Brown's motor, the principle is utilised in a somewhat different manner, the field magnet rotating, the armature being fixed. This latter consists of perforated iron stampings of a cylindrical shape, the coils being wound through the perforations and connected in series. This manner of winding (which diminishes the magnetising current, and effectually prevents eddy currents in the armature conductors) will be more particularly described in a later part of the paper, as it is common to all Mr. Brown's alternate current motors. The field magnet is multipolar, and runs within the cylindrical armature, having the commuting device arranged on one end of the shaft.

At starting, field and armature are placed in parallel, an alternate current running through each. As the speed increases, the commutator comes into play, and at a synchronous speed the field magnet is traversed by a direct current, an alternate current running through the armature. It is thus practically a self-exciting reversed alternator when the normal speed is once attained, and might have been very well classed with the constant magnetic field motors previously described.

This motor possesses but a very small starting torque, and hence must be started on a loose pulley, the load being transferred to it when synchronism has been attained. It may, however, be overloaded to a considerable extent without pulling up.

It was early known that condensers of any kind possess the property of neutralising self-induction. Hence several attempts have been made by different inventors, notably, by Messrs. Stanley and Kelly, and by Messrs. Hutin and Leblanc, to annul the self-induction of the field magnets of motors of this class by putting a condenser either in series or as a shunt to the field circuit, and sometimes (in the case of a shunt motor) in the armature circuit as well. The best way of applying the condenser is to put it in series with the field magnet winding, if a shunt wound motor, and in parallel to the whole motor if a series motor.

Figs. 3 and 4 show this:—R is the starting resistance, A the motor armature, F M the field magnet coils, and K the condenser. Also, owing to the relatively high pressure which might occur at the field terminals, owing to fluctuations in the field current, it is better—and, indeed, almost necessary—that the field magnet should be wound in sections, with smaller separate condensers to each section, as Mr. Swinburne has pointed out.

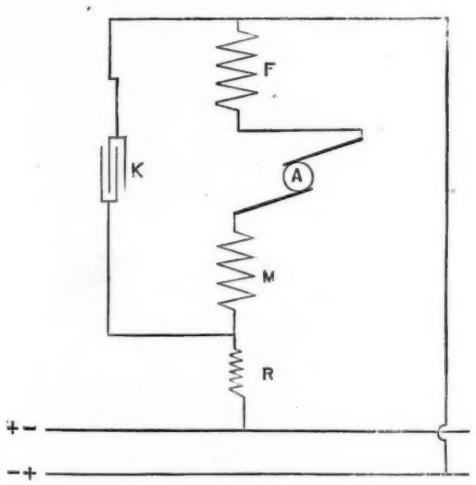


Fig. 3.

The capacity of the condenser should be adjusted for full load, as then armature reaction is greatest. The required capacity may be found as follows:—Take the case of a series motor shunted by a condenser, this being its most effective application. With a given frequency of alternation, the current lags behind the impressed pressure by an amount dependent on the self-induction and resistance of the motor circuit. This lagging current may be regarded as being made up of two components, one in phase with the impressed E.M.F. (the "working" current), the other at right angles to it (the "idle" current). The current flowing through the condenser has a negative lag with regard to the impressed E.M.F., the magnitude of this negative lag being determined by the capacity and resistance of the circuit containing the condenser, and if this resistance be very low, the lead produced will be, approximately, 90°. If, therefore, we place as a shunt to the motor a condenser of very low resistance, and of such capacity that the current driven through it by the impressed E.M.F. of the mains shall be equal in magnitude to the lagging component of the motor current, these two being 180° apart, will completely neutralise one another, leaving nothing but the ohmic resistance of the motor

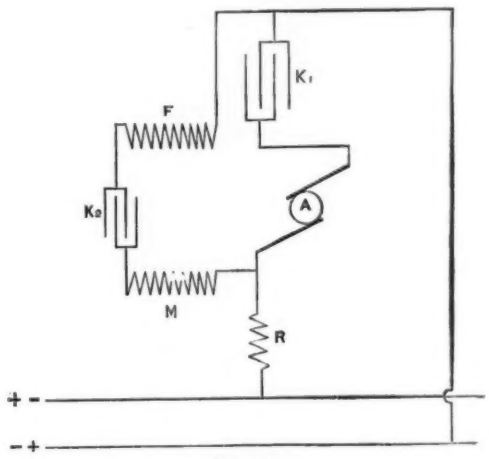


Fig. 4.

circuit to the passage of the current. This is of course the theoretical idea; in practice, for reasons presently to be stated, it is far from being so perfect as it sounds.

The use for this purpose of condensers made up in the ordinary way appears to be almost prohibitive, owing to the large amount of space required and the excessive cost, even supposing they could be made to stand the heating action of the current. Messrs. Stanley and Kelly have long used condensers in this connection constructed of a series of non-conducting cells containing either acidulated water or caustic potash. Two strips of either sheet lead or iron, depending on the liquid used, are placed in each cell. A number of these cells, depending on the capacity required, are placed in series, and they then act (by polarisation) like an ordinary condenser.

But condensers of this description, when left permanently in circuit, rapidly deteriorate, owing to the heating action of the current which is always running through them, and to the chemical action of the liquids on the electrodes. Otherwise, they are very successful—a large capacity and the requisite low resistance can be attained in a small compass and at a comparatively low cost.

Quite lately, Messrs. Stanley & Kelly have proposed the use of over-excited synchronous motors running light, as substitutes for condensers.

This is represented in fig. 5. M is the circuit containing self-induction, connected across the alternate current mains. This circuit might be a series motor of large size. A is the armature of the

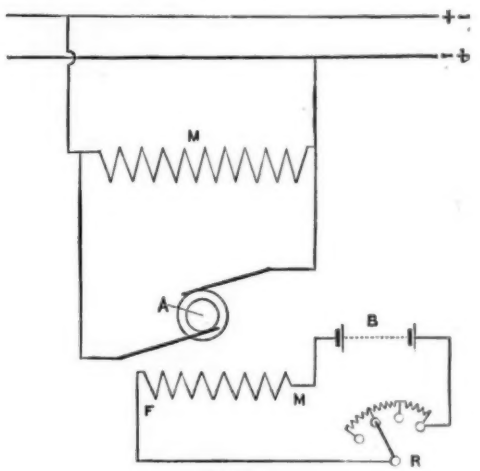


Fig. 5.

synchronous motor running without load, it being placed across the inductance M. B is a source of continuous current, applied to the field magnets, F M, of the synchronous motor through a regulating resistance, R.

The lead of the armature current is controlled by the excitation, as I have already shown in the first part of the paper, and this lead may be pushed to nearly 90° without the motor getting out of step. Of course this could not be done if there was much load on the motor. The resistance of this shunt circuit containing the lead, including the

armature of the motor, and the character of the latter for any particular case, are so adjusted that the current driven through it by the E.M.F. impressed by the line is equal in magnitude to the lagging component of the main current, and will thus neutralise it, as previously explained.

The use of an over-excited synchronous motor in this connection would seem to be particularly applicable to systems operated by low frequency currents, or where a large amount of self-induction has to be neutralised, in both of which cases the cost and capacity of ordinary condensers would become very great.

The general objections to the use of condensers in any shape are:—

1. Owing to armature reaction, the condenser will not annul the self-induction of the field magnets at all loads—armature reaction acting like a capacity in series with the fields.

2. The adjustment of the condenser is only right at one particular frequency.

3. The necessity of sub-dividing the field and condenser, as already pointed out, which leads to complication and expense.

4. The waste of energy (either as heat, or "dielectric hysteresis," or both), which must necessarily occur.

It has been already pointed out that one of the great objections to the shunt wound laminated field motor is that the maximum magnetic effects in armature and field magnets occur at different intervals of time, due to the lag of the armature current being different to that of the field current.

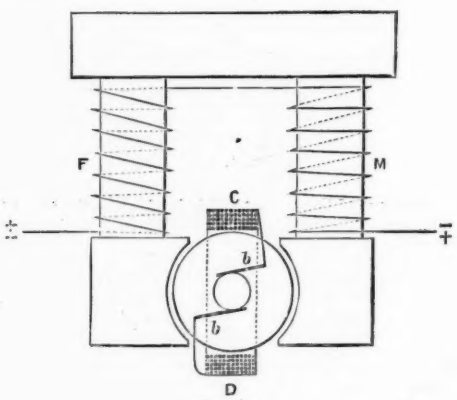


Fig. 6.

Messrs. Stanley & Kelly have attempted to meet this difficulty in an interesting way. They put a condenser (of the liquid type) in series with the field magnets, and place short-circuited coils in recesses cut in the pole-pieces. These coils have currents induced in them by the armature current, and proportional to the latter. They will thus act like the secondary of a transformer—the direction of the currents induced in them always being in such a direction as to decrease the self-induction of the armature coils. Hence the lag of the current in the latter will be less, and could be arranged to be the same as that in the field coils.

This device is open to the objection of causing a distortion in the main field of the motor.

A somewhat modified form of the above, also due to Messrs. Stanley & Kelly, is shown in fig. 6. The field magnets of the motor, F M, are put right on the mains. A demagnetising coil, C, D, is fixed in space right round the armature, having its convolutions parallel to

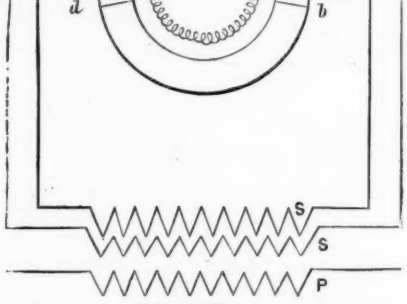


Fig. 7.

the armature conductors and to the field magnetisation. The two brushes, b, b, are connected to the ends of coil, C, D, in such a way as to give it a polarity which will assist the main field. This coil will therefore neutralise the effects of armature reaction, and hence the motor will have a better speed regulation, and also would probably, by its transformer action, reduce the impedance of the armature coils.

Mr. Sayers and Mr. Eickemeyer have also designed motors on the same lines as the above, but with a further provision in the shape of an arrangement for introducing an opposing E.M.F. in the coil which is short-circuited under the brush, to get rid of the heavy sparking which would otherwise take place.

Mr. Kingdon has devised a very simple arrangement for attaining the same thing, shown in fig. 7. Here C represents the commutator (shown outside the armature coiling, for the sake of clearness), having the width of its insulating segments relatively to the width of the metallic segments wider than usual. Two or more pairs of brushes, a, a, and b, b, press on the commutator. The width of any one brush is made less than the width of an insulating segment, and the distance between each pair, such as a, a, bears such a relation to the width of the insulating segments, that one brush of the pair is always in contact with a commutator bar, so the circuit is never broken through the armature. These brushes are connected to the ends of a specially wound transformer, having as many secondaries, S, S, as

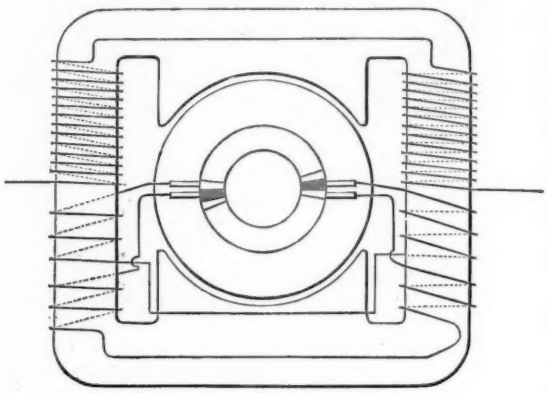


Fig. 8.

there are pairs of brushes. This transformer may be the field magnet of the motor, the primary coil magnetising the field, and the secondary coils supplying current to the armature. This is shown in fig. 8.

There are several modifications of this plan, in all of which, however, the condition is that the short-circuited coil shall have little or no current in it at the moment its segments pass under the brushes. This is easily seen from an inspection of figs. 7 and 8.

Messrs. Hutin & Leblanc have devised an interesting form of armature for motors of this type, it being arranged that no section can ever be short-circuited by a brush. The armature core is wound with two distinct windings which may be either as a ring or drum. The number of sections in each winding must be a multiple of four. The commutator segments are equal in number to the total number of sections round the armature; that is, are equal to the number of sections in the first winding plus the number of sections in the second winding.

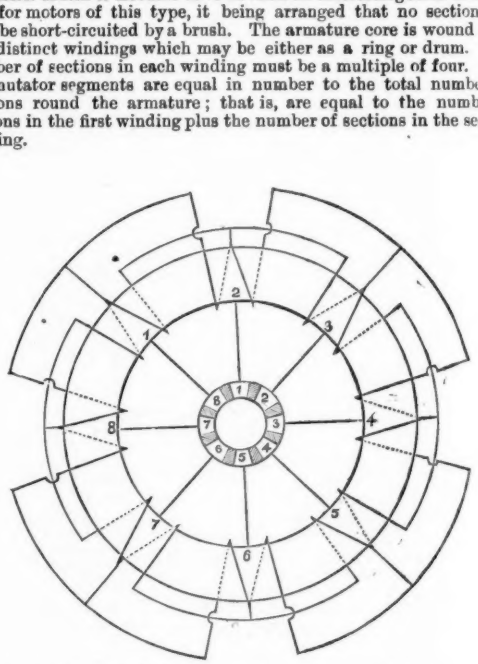


Fig. 9.

Fig. 9 represents a ring wound armature on this plan. For the sake of clearness only four sections in each winding are represented, and hence an 8-part commutator. The ends of all the even numbered sections are connected together, their point of union being connected to an even numbered commutator bar.

Similarly the points of union of all the odd numbered sections are connected to odd commutator bars.

Thus two distinct armatures are formed, each with its own com-

mutator, the even numbered sections constituting one armature, and the odd numbered sections the other; but the two systems are, as it were, interlaced with each other, and operate simultaneously, the double armature simply acting as if its conductors were alternately of a certain section, and half that section, depending whether the brushes touch on two commutator segments or only one. The waste of energy is very little, as the width of brush can be so adjusted with regard to the width of a commutator segment that the two armatures are generally in parallel. It is also as well to make the sections on the armature numerous, as then the loss of energy due to the end coils having their current reversed is insignificant.

The last motor under this heading that will be described is that of Mr. H. F. Joel. It is the only alternate current motor that I know of in everyday use that is self-starting under full load, even when run on a circuit of frequency 130.

The field magnet is built up of stampings of the shape shown in fig. 10, these being made of the softest iron in order to reduce the hysteresis loss as much as possible. Each stamping is insulated from its neighbour by a thin sheet of shellaced paper, and the whole held up by means of insulated bolts, thus reducing eddy currents to a minimum. The winding generally consists of four layers on each limb, joined in parallel, the whole winding being placed as a shunt to the armature. The objection to a winding of this sort is that the different layers of wire exert an injurious transformer action on one another. Mr. Joel finds that an improved result follows if there be

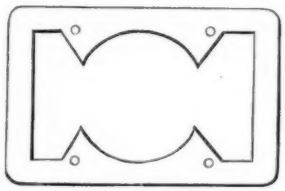


Fig. 10.

inserted between each layer of winding on each limb intermediate coils, wound in the opposite direction to the main winding, the ends of each of these coils on the one limb being cross-connected to the ends of the corresponding coil on the other limb. Although on practically short-circuit no current (or very little) actually flows through these intermediate coils, owing to their being cross-connected. They simply act as separators, and protect the different layers of field winding from inductive action due to other layers.

The armature is a double-wound drum, the principle of which has been already described. Unless special precautions are taken to make the length, resistance, &c., of each coil exactly the same, an inductive action will go on between the coils of the two windings, with injurious results. Mr. Joel's system of winding, and method of spacing, enables this to be done with considerable ease, each coil being separately wound and then fixed in position in pairs on the core.

The exact winding, number of turns, &c., of both armature and field coils depends on the periodicity of the circuit upon which the motor is to be run.

This motor is very successful in practical work—at any rate, in the sizes already made, such as ¼, ½, and 1 H.P. As regards ease of starting, reversing, and absence of sparking, it is fully equal to a continuous current motor. An example which has recently come under the author's notice may be instanced in this connection. The motor is of ¼ H.P., running on a circuit of 100 ~, and is used for driving hair-brushing machinery. It has now been running for about 18 months, starting and stopping from 200 to 500 times a day under full load, and when seen, the commutator was in surprisingly good condition, considering the trying work.

Of course, the great drawback is the low efficiency attained—this is about 40 per cent at full load in ½ H.P. motors.

THE TELEPHONE COMMITTEE.

The Parliamentary Committee, of which we publish the concluding evidence to-day, commenced its sittings on March 22nd. Its *locale* was Committee Room No. 15, famous as the scene of more impassioned proceedings in connection with the Irish Parliamentary Party. The Committee which is now considering its report is a very representative one, consisting of official members and ex-official members, municipal members and anti-municipal members, whilst to those attending, the accent of Sir Charles Cameron and the brogue of Mr. Tully were evidence that the Committee was fairly representative of localities.

Mr. Lamb, who was the last witness, was also the first, and gave evidence detailing the existing telephonic conditions, and what had led up to them. He thought it was obvious that the taking over of the trunk wires by the Government was a step in the direction of the acquisition of the telephones. At the sitting on March 29th, the representatives of the Corporations of Glasgow, Aberdeen, and Dundee, combined to complain of the existing service, and to do their best to obtain a municipal license, one witness stating that he felt strongly that if the State did not take over the telephones, the municipalities ought to; another expressing the opinion that local management would be better than State control, as defects could be more easily remedied. On April 5th Mr. Clare, the deputy town clerk of Liverpool, and Mr. Harrison, the town clerk of Leeds, gave evidence on behalf of the Municipal Corporations Association. Their evidence was of a different complexion to that of the Scottish representatives. Mr. Clare gave the telephonic service of Liverpool a good character, but Mr. Harrison intimated that there was dissatisfaction about the Leeds service in consequence of the interruption of conversation. Mr. Clare's examination by the chairman covered a great deal of ground, and the replies indicated some study of the question. He regarded the telephone system as a national one. The Government ought to take over the whole system, but if they took over only the trunk lines, then there was only one course to be followed, and that was to place the whole of the local exchanges in the hands of one body and under one control, and with a view to that he suggested some plan of give and take whereby, in his opinion, this might be attained. Expressing the opinion of his association, he thought the municipalisation of local areas impracticable and wrong in principle. Mr. Harrison thought competition would be regrettable, and he would only allow it where the company failed to give a cheap and effective service. In the examination of this witness, Sir James Ferguson recited the terms which had been arrived at between the Manchester Corporation and the Telephone Company—the company to lay twin wires as far as possible; the subscription not to be increased without the Corporation's consent; every citizen to be entitled to supply, and no monopoly to be conferred thereby. Mr. Harrison would especially want a maximum charge, but provided a fair charge could be fixed, he thought such an arrangement would be better than the Corporation having it themselves. Mr. Dickinson, the Deputy Chairman of the London County Council, was the next witness, but his evidence had not proceeded far before points of order were raised which led to an adjournment until April 26th, when Mr. Dickinson again took the witness chair. He objected to the agreement because it increased trunk line charges and to the terminal charges, which would have the effect of giving a certain pull to the National Telephone Company over any other body carrying on telephone business, but he thought the position materially changed on the expression of the chairman's opinion that if licenses were given to other companies the same facilities would be given. Mr. Dickinson's evidence included complaints against the existing service, the charge made for it, and an attempt to demonstrate that the high subscriptions were largely due to the amount of capital which represented inflated values but upon which dividends had to be paid. On the other hand, he presented estimates of the capital expenditure necessary to provide for 10,000 subscribers in London. These estimates were of such widely-differing amounts as £76,000 and £400,000, but they all provided for subscription rates of £8 to £10 per annum. Mr. Dickinson was subjected to a somewhat severe examination by Sir Julian Goldsmid, who desired to ascertain whether Mr. Dickinson represented the County Council or was simply expressing to the Committee his own views. It was elicited by other members that the area covered by the estimates was smaller than the area served by the National Telephone Company. Mr. Dickinson was succeeded by representatives from the London Chamber of Commerce, who expressed the views of the Chamber as embodied in a series of resolutions passed by a meeting of members of that body; but neither the resolutions nor the evidence of the witnesses contributed any valuable suggestions of a practical nature. The representatives of the City of London were in accord with the County Council in complaining of the service, but were not prepared to give the Council control of the City streets if a license were given them. The City representatives were succeeded on April 30th by a number of witnesses from Scottish towns, who were called by the Telephone Company to counteract the previous evidence as regards the service in Scotland. As one of the witnesses was manager of an omnibus company, Mr. Benn's

examination suggested that there might be some bias against a municipality which owned the tramways. Another witness being a journalist, without any proprietary interest in his paper, Mr. Benn feared might not sufficiently appreciate the advantages of a reduced subscription. At the meeting on May 3rd, Mr. Provand, M.P., was the first witness, and there was considerable difficulty in keeping him within bounds. He was provided with numerous papers, and gave his evidence with great volubility. It was to have been limited to terminal charges; but by dint of sheer irrepressibility, he succeeded in bringing in twin-wires, much special information, and many general complaints. Mr. Provand was succeeded by Mr. Preece, who gave a general summary of the technical features, and also gave reasons why the telephone system was unsuited to municipal management. As might be expected, Mr. Benn directed his examination of the witness to these features, and Mr. Moulton, combining the lawyer with the councillor, did his best at a species of cross-examination about the number of separate operations involved in trunk connections going through numerous exchanges, but neither Mr. Benn nor Mr. Moulton succeeded in altering the expression of the witness's views. Mr. Snape's interest was in switchboards, and he seemed very desirous of knowing how a multiple board grew, and what principle was involved in its extension. He supposed that it was not beyond the range of possibility that the switching might eventually be done automatically, to which Mr. Preece replied that, "in the vocabulary of the electrical engineer, there is no such word as 'impossible';" but he added that there was at present no indication of its practicability on a large scale. Mr. Preece was succeeded by Mr. Crompton and Prof. Silvanus Thompson, on behalf of the Institution of Electrical Engineers. Mr. Crompton was understood to say that they were desired to attend by a Committee or some members of the Council of that body. As President of the Institution, he found but little interest in telephone affairs amongst the members, and, as a teacher of youth, he found no interest taken in the subject. He urged competition, thinking that it would develop invention, and that a number of young men would find profitable employment in starting exchanges in opposition to, or independent of, the existing company. Prof. Thompson, as technical adviser to the London and Globe Telephone Company, had satisfied himself that competition was possible, if there were any monopoly, it should be in the hands of the State. He endorsed Mr. Crompton's view of the advantages of competition to students and young men, whereupon the chairman asked whether he would suggest that the Committee would be justified in considering the matter from the point of view of the advancement of young men? Major-General Webber was the next witness, and his evidence occupied the whole of the sitting on May 14th. General Webber condemned the London system altogether—in fact, rather objected to the word system being applied to it, maintaining that it had been allowed to grow in a haphazard way. At the request of the chairman he unfolded his own plan. This was to provide eight exchanges within the square mile of the City, and provide underground tubing giving facilities for 28,000 subscribers which the eight exchanges would be adapted to accommodate. Taking London as a whole, it would be divided into areas, with a subscription covering that area, communication with other areas to be paid for either by message or increased subscription. The subscription for one area was to be £8, but the present rate for the whole of London he thought not excessive, if the service were satisfactory. The Hon. J. G. Ward, Postmaster-General of New Zealand, gave evidence as to the telephone exchange service in that colony, and showed that the reduction of rates had led to a large increase in subscribers. The total cost of the system up to the end of the last financial year was £104,500, and the total earned £183,800. Their subscription was £5 per annum within one mile of the Exchange, with £1 entrance fee. Mr. Dickinson having, at his first examination, referred to the unsatisfactory service in London in general terms and without the production of specific complaints, attended again on May 21st to report that the Council had issued circulars to 7,329 subscribers, to which they had received 2,536 replies, of whom only 555 were entirely satisfied. Of the remainder 1,305 expressed general dissatisfaction, 350 had no suggestions to offer, 326 were satisfied but suggested improvements. Mr. Forbes, the chairman of the National Telephone Company, followed, and commenced his evidence by stating that his company had also sent out a circular to their London subscribers, and had received 2,346 replies objecting to the Council undertaking the service, and expressing reasonable satisfaction with the existing service of the company, 266 signed with qualifications, and only 43 were in favour of the Council. Mr. Morton, M.P., subsequently gave the results of a circular sent out by the city authorities, and created some amusement by saying that no reliance could be placed on the replies to the company's circular, because the feeling in the City was so strong against the County Council. Of Mr. Forbes's evidence it is impossible to give a summary, or to make adequate selections. It was designed to controvert the various statements which had been made, and to show by actual expenditure the chimerical nature of estimates submitted. The keenest examination to which Mr. Forbes was subjected was by Mr. Benn, who referred to the estimates in the New Telephone Company's prospectus, which bore Mr. Forbes's name, and sought to show that those estimates and the estimates of the County Council were very similar in amount, and he endeavoured to make Mr. Forbes's endorsement of the prospectus an endorsement of the estimate. He could not, however, obtain more satisfaction than Mr. Forbes's statement that they "hoped" the estimates were right, but examination and experience had shown very much the contrary. Sir Charles Cameron's examination of Mr. Forbes was mainly directed to the question of capital, using the word "water," to which Mr. Forbes demurred, remarking that there was a good deal of "spirit" in it. The construction account at December last amounted to £3,272.000, and the "water" to £1,292,000. Other figures given by Mr. Forbes were that in London it cost £55 to put an instrument into a subscriber's house, and wayleaves cost £1 13s. 4d. per subscriber per annum, and the small use of the telephone, as compared with some other countries, was due to the larger use of the telegraph, as shown by tabulated statement put in. The inutility of local service, as advocated by some of the witnesses, was shown by the case of Croydon, which had 61 subscribers to local service, with 250 having full metropolitan service, and Kensington having 3 and 342, respectively. After Mr. Forbes, Mr. Lamb gave some brief information upon points which had been raised, stating that in Major Webber's estimate junction lines between exchanges were not included, gave it as the opinion of the late and present engineer-in-chief that the tubes laid on behalf of the New Telephone Company were unsuited for the purpose, and added that in providing for 28,000 subscribers in the City area, Major-General Webber was providing for a telephonic connection to every separate tenancy in the City of London, and something over. At the conclusion of Mr. Lamb's evidence, the Committee adjourned to consider their report. The evidence placed before them has been voluminous but by no means exhaustive, some not very relevant, and some of a nature not very readily absorbed. To all the Committee listened with patience and attention, any chance of misunderstanding being usually prevented by the chairman, whose grasp of the subject before the Committee was such that a few final questions from the chair, carefully chosen and clearly expressed, often elicited more valuable information from witnesses than a prolonged "examination in chief." A striking feature of the evidence seemed to be the very general expression of opinion by witnesses from all sides in favour of Government undertaking the service.

CORRESPONDENCE.

Lighthouse Illuminants.

In your leading article of the 31st ult., referring to the paper which I read before the Shipmasters' Society on this subject, you have fallen into error in supposing that I am biassed against the electric light. I think you are aware that, in my daily avocation, I am more extensively engaged in installing electric light than gas light, and therefore my bias, if you suppose it to arise from trade associations, is more likely to be favourable to electricity than otherwise.

You entirely mistake my reference to Prof. Tyndall, Lord Kelvin, Sir George Stokes and others. I have urged the Lighthouse Authorities to make a fair trial between electric light and gas light, going the length, as my paper shows, of offering at my own expense to provide the necessary apparatus. I have done this because I think it important that a matter of such moment to navigation as definitely fixing which is the better light for lighthouse purposes should be absolutely settled, and the names of these eminent persons are only mentioned by me as agreeing with me that this trial should be made.

It is true that I myself hold a strong opinion, based chiefly upon my long practical experience of the operation of both lights, that for lighthouse purposes the electric light is not so good as gas light, but I have always held that the correctness of my opinion, and that of the shipmasters who agree with me, not three only, as you say, but hundreds, should be tested by absolute trial. That such a trial has not yet been made is certainly not my fault. Notwithstanding the severity of your criticisms, I think you, as an impartial, unbiassed advocate for the elucidation of the truth in this important matter, will use your influence to have this trial made.

John R. Wigham.

[We thank Mr. Wigham for his very courteous reply to criticisms which he has taken in such good part, and if he will favour us with his suggestions for the trial which every electrician would hail with satisfaction, we will certainly do all that lies in our power to bring it about.—Eds. Elec. Rev.]

To English Wire Makers.

Our attention having been called by your comment to a statement made by Mr. Forbes before the Telephone Commission, reflecting on English made wire, we could hardly allow such a statement to pass unchallenged. The statement is vague enough to include all kinds of wire, but if it be copper wire that is referred to, we may say that, so far as quality is concerned, we have no fear whatever of German competition, either with regard to conductivity or mechanical excellence. We hear sometimes of somewhat lower prices from that quarter; surely, if the quality of German wire were superior, it would find acceptance on equal terms.

It is significant, also, that we hear very little of the competition of German wire where the specification is difficult, and inspection is rigid.

May we add also that the National Telephone Company, which is entirely supported by English subscribers and without outside competition, might not unreasonably be expected to obtain its supplies at home.

Frederick Smith & Co.

Halifax, *June 10th.*

Interior Conduit Wiring.

We have read with much interest the description you published in your last issue (June 7th) of the conduit system of wiring as adopted by the London and Lancashire Electric and General Engineering Company. Whilst fully recognising the advantages of conduit systems and the many good features included in this particular system, and admitting also that there are certain mechanical advantages to be gained by the use of iron pipes, we venture to think that there are many who will agree with us that the *necessity* of using iron pipe *throughout* a building in preference to the paper or composite tubes which are now in the market is quite an open question.

It would be fairer to say that the contractor should exercise his judgment as to the grade of tube to be employed, and make a selection which will meet the contingencies of the position.

As a parallel it should be remembered that time and experience have dictated the advisability of having more than one grade of insulated wires.

The advocates of insulating conduits hold that commercial advantages indicated to them the advisability of providing various grades of conduits, both armoured and unarmoured. It would seem that unnecessary expense is incurred when an iron pipe is used in positions which are unassailable by nails or screws. "Moisture damage" is far more to be feared than "mechanical damage," and in this respect insulating conduits must always have the advantage. We are glad to see that the subject of wiring, which is becoming one of such pressing importance, is receiving attention at your hands.

The Electrical and General Engineering Company,
Louis Schramm.

Alternate Current Motors.

In a paper on "Synchronous Motors" by W. G. Rhodes, M.Sc., in the Review of March 29th, the following equations are made use of:—

$$p = c\, e \cos \phi$$

$$E^2 = e^2 + e^2{}_0 + 2\, e\, e_0 \cos (\theta - \phi).$$

I should like to ask Mr. Rhodes whether the first should not be $2\, p = c\, e \cos \phi$,

and the second

$$E^2 = e^2 + e_0{}^2 - 2\, e\, e_0 \cos (\theta - \phi).$$

Student.

Ewing's Magnetic Tester.

I notice in the reports given in your valuable journal of the discussion on Prof. Ewing's paper on "A Magnetic Tester," Prof. Forbes speaks of an apparatus made here some years ago, and used by the General Electric Company, accrediting me with the design. I wish to say that the design of the instrument was due to Mr. Frank Holden, who was employed in the instrument department of the company, and that he intends shortly to write a description of the instrument, and give the results which he has obtained in its use.

Prof. Forbes's error in accrediting this instrument to me was natural under the circumstances, as I had spoken to him of another instrument made some years previously, I think in the latter part of 1889, in which a pile of discs of standard size were driven in magnetic fields of varying strength by a small electric motor on the principle of the motor used in my recording wattmeter. A reading of the current required to be passed through the meter motor to overcome friction at any speed, in the absence of any magnetic field acting on the discs, was first taken, and another reading when the field was present. From the difference of these two readings the energy used in revolving the discs was easily obtained. Mr. Holden's instrument, however, is much nearer the simplex instrument proposed by Prof. Ewing.

Elihu Thomson.

Lynn, Mass.,
May 31st, 1895.

REVIEWS.

Steel Works Analysis. By J. O. Arnold, F.C.S. Whittaker & Co., London and New York, 1895. 10s. 6d.

This volume is one of Messrs. Whittaker's "Specialist Series," its author, professor of metallurgy in the Sheffield Technical School, and once chemist at the Sheffield Steel Works.

It has been written for students and assistants in steel works' laboratories, and the author's object has been to avoid compilation and write only from personal experience; a wise decision which might be followed frequently with advantage by many book makers who do little else than digest a mass of trade circulars, and slapping on a pair of covers thereby become authors forthwith. Chemical analysis is a matter of determining such very minute quantities of matter that may, in steel, exercise an influence out of all proportion to their amount, that the author's caution as to cleanliness and attention to detail is in no way superfluous. Commencing from the beginning we find, first, a description of the laboratory and its internal arrangements with sound practical notes throughout. Thus the ceiling should be of wood not of plaster, which is apt to scale under, or rather over, the fumes from acid.

Both the knife edges and planes of the balance must be of agate or crystal for steel may corrode. Description of apparatus, and a list of all apparatus and re-agents required in the laboratory are set forth, from which it appears that the complete outfit can be had for £70. Then follows a list of the various materials that a chemist may be called on to test—it includes iron and steel and ferro compounds, ores, refractory materials, fuels, slags, and water. An italicised paragraph tells once for all of the importance of procuring all samples by means of a dry drill, *i.e.*, one using no oil or other lubricant or water; filings are useless as samples, because of the file teeth fragments certain to be present. The determination of carbon is the main duty of the chemist, and, of course, occupies a large space in this book. Its liberation from steel is effected in three ways—one of them galvanic, but suitable only for use when the sample can be had in bulk. It is liable to error from a slight evolution of hydro-carbon gas at the iron pole.

The action of this process is thus expressed, $Fe + 2\,H\,Cl = Fe\,Cl_2 + 2\,H$. The carbon remains and is estimated by combustion in oxygen and absorption of the CO_2 by caustic potash tubes in the usual way with the various customary precautions, the apparatus and arrangements for this being exhibited at length on plate fig. 7. All the reactions are explained, and at each point where an inexperienced student might make an error in applying a flame too quickly or doing something equally simple, there is introduced a word or two to set him on his guard against it. Over the various descriptions of processes there is given the time occupied, not necessarily by the chemist himself on that particular analysis, for he may have more than one analysis on hand at one time—but from beginning to end of the work.

Throughout the book the same thoroughness of detail continues, and it should prove exceedingly useful to others than merely the special class for whom it is intended. Steam users would find the chapter on water of service, and the appendix explains a neat method of calorimetric determination of fuels very useful for the coal user. The appendix concludes with tables of typical analyses, of atomic weights of the more important elements, and of percentages of elements or compounds in certain precipitates. Altogether, this is a very complete and good work. We note an error on page 306, 11th line from foot of page where "*absorb*" is misprinted "*about*."

Regarding the colour test for carbon, a note of warning is sounded as to the dangers of this method and the unreliableness of so-called "Standard" colour tubes. Thus it is laid down that the standard solution must be made from material produced by the same process as the sample to be tested. The amount of carbon must not be far different in the standard and the sample, and the solutions of the steel to be tested and of the standard steel should be made at the same time and compared without delay. This looks like a direct condemnation of the whole system of permanent colour tubes. At the Sheffield School the standard steels consist of seven bars ranging from 0·09 to 1·60 per cent. of carbon. The chief value of a colour test is the rapidity with which it can be made, viz., 45 minutes. In drilling a bar for testing it should be drilled right through and the drillings well mixed, and even then several estimations should be made, and the mean taken. Against blister bar, especially, it is necessary to be on one's guard, seeing that by its very process of manufacture it cannot be homogeneous, and a shallow drilling would be wholly misleading.

There are numerous notes and references to fuller sources of information, also cross references to other pages of the book itself. The arrangement is good and the chemical formulæ and figures are clearly printed, all chemical letters and formulæ being in italic type, and mere arithmetical figures in ordinary type. This is a great assistance to the eye.

Indicator Diagrams and Engine and Boiler Testing. By Charles Day. The Technical Publishing Company, Limited. 1895. 4s. 6d.

This is a book that should appeal to a large circle of readers, containing as it does directions for the use of the indicator, descriptions of various types of the instrument, showing the development from Watt's original design and numerous examples of actual diagrams to illustrate points which the indicator is so useful in elucidating. The author's connection with the National Boiler Insurance Company affords him singularly good opportunities of gauging the requirements of the readers for whom he writes, and furnishes as well the practical experience necessary to enable him to deal with the subject in a clear manner. Only those who have had the duty of indicating steam engines for an engine insurance company can have any true idea of the variety of gears, correct and otherwise, oftener otherwise, that are supplied for the purpose of actuating the instrument. Indeed it is rare to find an absolutely correct reducing gear, while the great length of cord often necessary is sufficient to render the diagram incorrect even when the reducing gear is true. All these points are noted.

We note that Mr. Day uses the hyperbolic curve as the curve of comparison in diagrams. The use of this curve is altogether so very much simpler and more rapid than the use of the so-called curve of saturation that it is a pleasure to find Mr. Day has the courage not to be drawn into the pedantic ways some writers and speakers are inclined to follow. The man who really knows his indicator practice, and can follow the action of steam in a cylinder, knows full well that the hyperbola is the only common-sense curve to employ for general comparisons. Valve motion diagrams are explained, and the student is shown diagrams of various forms, from which may be estimated the probability of leaking valves or pistons and other faults, and the questions of cylinder condensations, and the gain due to compounding, are briefly and correctly dealt with. Copies are given of the diagrams from the first quadruple expansion engine ever made—that by the late Daniel Adamson—who, however, applied the quadruple engine to steam of only 100 lbs., and got as result one H.P. hour from each 1·77 lb. of coal burned; just about the results to be obtained from compound engines at the same pressure. But if Mr. Adamson's first and final cylinders had the proportions suitable for 200 lbs. steam, the engine would have shown better results with higher steam. Mr. Adamson was simply too early in the field, though even pressures of 100 lbs. at the time were only then possible by virtue of the Adamson flanged seam. The second part of the book relates to engine and boiler testing, and comprises directions for making such tests, for approximately analysing flue gases, and collecting same, descriptions of instruments, &c. The chapter on testing steam dryness might almost have been omitted, except as a matter of history. There are such grave doubts on the correctness of the methods employed to collect samples of steam that shall truly represent the quality of the steam in the pipe, that the determination of the quality of the sample is practically useless in face of such doubts. The salt test is even abandoned by its particular friends, and we cannot understand how such a test could ever have been taken up by practical men; it is so altogether the method of the *dilettante* in engineering, and has too many loopholes for inaccuracy ever to have been allowed to be imported, for we believe it was made in Germany. The volume concludes with a few tables, including Fowler's table of engine constants expressed as I.H.P. per lb. of mean pressure at piston speeds from 100 to 1,000 feet, and with cylinders of every size from 10 inches to 100 inches, increasing by $\frac{1}{4}$th of an inch. The book is just what is wanted by the engineering student and practical man. In no sense a complete treatise, it carries the reader to a certain point, and indicates the course to be pursued in acquiring more complete information. It is a book to be commended.

LEGAL.

A Duplex Telegraphy Action.

Mr. Justice Kekewich, sitting in the Chancery Division of the High Court of Justice, was engaged for several hours on Tuesday last in hearing a motion by Sir Richard Webster, Q.C. (with him Mr. Bramwell Davis, Q.C., and Mr. Pollard), for the stay of an action brought by Mr. Joseph Barker Stearns against Mr. John Muirhead, Mr. Alexander Muirhead, Mr. H. A. Taylor, and the Commercial Cable Company, the ground of the application being that it had been agreed between the parties that all questions in dispute should be referred to arbitration.

The substance of the learned counsel's opening statement for the defendants, except the Cable Company, was to the effect that before the year 1877 Mr. Stearns held letters patent in this country relative to duplex telegraphy, a system which Messrs. Muirhead claimed to have perfected all over the world. In 1874 Mr. Stearns claimed that his patent covered the ground occupied by defendants, who, in 1874, 1875, 1876, and 1877, patented a number of improvements. The plaintiff threatening all persons who were contemplating adopting duplex telegraphy in England, the Messrs. Muirhead and plaintiff, in April, 1880, came to heads of an agreement, reduced to print, which provided that the pending actions by Stearns for alleged infringement against the Direct United States Cable Company and the Submarine Telegraph Company should be stayed, each party to pay its own costs. Stearns and Muirheads were to combine their patents, English, colonial, and foreign, for duplex telegraphy, and to unite in an effort to obtain further royalties and maintain those agreed upon, all the royalties thus obtained to be divided equally between the parties as from March 25th, 1880, all claims by Stearns in respect of the previous period being abandoned, and all expenses of recovering royalties and negotiating future royalties to be borne by a joint purse. All necessary and proper documents to carry out these heads of agreement were to be executed, the terms and forms of such documents to be settled, in case of difference, by Mr. Romer, or failing him, Mr. Rigby, barrister-at-law — now respectively Lord Justice Rigby and Mr. Justice Romer. There were other provisions as to meeting duties and annuities falling due on patents, &c., the final provision being that the "general arbitration clause" was to apply. In an action of Muirhead *v.* The Commercial Cable Company (the date of which was not given), the Muirheads, defendants in the present action, received as a compromise £19,500, each party paying its own costs. As soon as that compromise was entered into, Stearns commenced the present action for a declaration that under the agreement just noticed he was entitled to a moiety of the £19,500, payable to Muirheads by the Commercial Cable Company (who were joined in the action), and asking also for an injunction to restrain the defendant company from paying to the other defendants, and the other defendants from receiving, more than one moiety of the said sum, or in the alternative for a receiver, and finally asking for an account. Messrs. Muirhead, Sir R. Webster said, had offered to deposit in Court £7,500, which was more than Stearns could possibly recover through his action; and he submitted that, so far from the plaintiff being entitled to proceed with the action, he was precluded by the arbitration clause from so proceeding. Should it prove in the course of the arbitration that there was any matter of law to be tried, there was power in the arbitrator to state a special case, and there was certainly nothing in the affidavits filed in the case suggesting anything which would deprive the defendants of the tribunal to which all the parties agreed at the time the agreement was made. Hence the present motion to stay legal proceedings.

For Mr. Stearns, the plaintiff in the action, Mr. Warrington, Q.C. (with him Mr. Hamilton), said there were points of law in the case as to the true construction of the agreement, which he submitted ought to be settled by the Court, only the other questions, such as matters of account, being left to arbitration. One of the legal points to be raised, and which he contended could not and ought not to be referred to arbitration, but settled by the Court, bore upon the question of a joint purse; and another was that the agreement was intended to include alike the patents then existing on both sides, and any improvements by either party, and also to cover all the royalties earned. This was one of those cases in which the Court expressly had discretion given to it by the Act of 1889, directing that points of law should be determined by the Court itself; and he quoted in support of his view decisions given by Mr. Justice North and Mr. Justice (now Lord Justice) Kay, adding that the Court could deal with the points in half an hour, and should the case go to arbitration, it was by no means certain that, after all, it would not have to come before the Court. Why, then, grant the stay asked for?

Mr. Hamilton, following on the same side, pointed out that if his Lordship should decide the points of law against the plaintiff, there would be no cause for going to arbitration at all. A useless expense might thus perhaps be avoided by allowing the action to proceed.

Without calling on Sir R. Webster to reply, His Lordship, summarising the facts, said that not having been convinced of the inutility of sending the whole matter for arbitration, he thought it better that the action should be stayed, and he ordered, accordingly, the costs of this motion to be costs in the arbitration, and defendants undertaking to pay £7,500 into Court to abide the result of the arbitration.

Shelfer *v.* City of London Electric Lighting Company.

An application was made by Mr. Fletcher Moulton, Q.C., on Wednesday, before Lords Justices Lindley, Lopes, and Rigby, sitting in the Court of Appeal, for a further stay of the operation of the injunctions granted against the City of London Electric Lighting Company in the actions of Shelfer and Meux & Co. against the electric company. The actions were brought by the occupier and the freeholders of the Waterman's Arms' public house, Bankside, Southwark, for an injunction restraining the electric lighting company from working their machinery in such a manner as to cause excessive vibration, to the injury of the plaintiff's property adjoining the company's works. Mr. Justice Kekewich refused an injunction, but directed an inquiry as to damages; but the Court of Appeal granted an injunction and suspended its operation for a month. It was further suspended to enable the electric lighting company to appeal to the House of Lords. An appeal was entered, but has been abandoned. The learned counsel stated that in February last the company appointed a new manager, Mr. Frank Bailey, C.E., who had advised the company that, by substituting Parson's steam turbines for vertical engines, and by other means, the vibration complained of would be overcome. The company had sanctioned their engineer's schemes, which would cost some £70,000 to £80,000. As the four new turbine engines could not be obtained and set to work until October next, a stay of the injunction was asked for until February, 1896.

Mr. Warmington, Q.C., opposed the application.

Their Lordships in the result granted a stay until August 5th, the defendant company giving an undertaking in damages. The defendant company was also ordered to pay the costs of the present motion.

Bocquet *v.* F. Suter & Co.

In the Chancery Division of the High Court of Justice, on Tuesday, the 11th inst., the trial of this action came before Mr. Justice Romer. The plaintiff was a dress and mantle maker at 66, Berners Street, and the defendants electric light engineers and manufacturers, carrying on business immediately below the premises occupied by the plaintiff. According to the plaintiff's case, the defendants, in connection with their business, carried on processes known as "dipping" and "lacquering," from which processes fumes of a noxious and poisonous character were given off. Under these circumstances, the plaintiff claimed an injunction to restrain the defendants from a continuance or repetition of the damage to her premises from the fumes, and also damages in respect of the nuisance complained of.

Mr. McCall, Q.C., and Mr. J. Ritchie Macoun appeared for the plaintiff; Mr. Bramwell Davies, Q.C., and Mr. Eve for the defendants.

Mr. Justice Romer came to the conclusion that a nuisance was caused to the plaintiff by the nitric acid fumes, and said that the defendants must stop that nuisance either by giving up the "dipping" process altogether, or taking further precautions than were taken at present. He accordingly granted an injunction restraining the nuisance referred to, and ordered the defendants to pay the costs of the action.

BUSINESS NOTICES, &c.

Ready.—The Universal Electrical Directory. This directory for 1895, which is on sale at 22, Paternoster Row, by Messrs. H. Alabaster, Gatehouse & Co., contains a total of 20,958 distinct names of individuals and firms, being 2,500 more than were contained in the previous edition, and about 8,000 more than any other electrical directory published. In addition to the incorporation of new names, all have been carefully revised, much financial information has been added, the telegraphic addresses and local telephone numbers are given, and the total of pages in the work is increased by 80, making in all about 866 pages entirely of directory matter. Price 4s.

Arc Lamps.—In our "Contracts Closed" column we refer to the contract for lighting the streets of Brighton with 130 extra arc lamps which has been placed with Messrs. Sharp & Kent, of Westminster. We understand that the choice of this firm was due to the fact that their tender was the only one which fully complied with the terms of the specification. This specification contained the excellent but novel feature that the strength of current to the lamps should be reduced from 8 ampères to 5 ampères after a fixed hour in the evening without extra contacts or cables of any sort. Messrs. Sharp & Kent have been enabled to fulfil this important condition with their new form of Andrews lamp (for which they are the sole licensees) in which the change from one current strength to the other is effected without interfering with the lamps, and moreover with no greater loss in the resistance than occurs when running compound lamps in series with a constant strength of current.

Catalogues.—Messrs. Cuttriss, Wallis & Co., Limited, of Leeds, have recently issued a neatly got up and nicely illustrated catalogue of their dynamos, motors, and electrical appliances. There is a variety of small dynamos and motors of different types for students and others, prices of which are given. The Elmwood electric air propellor, electrical fans, dental motors, &c., are also described.

Messrs. Girdlestone, Tatham & Co. have sent us an illustrated price list (May, 1895) of Andersen's patent arc lamps, of which they are the sole manufacturers.

J. P. Rushworth & Co.—This firm, of Bradford, has lately carried out the following electric lighting works:—A complete installation at the residence of Mr. G. D. Sykes, of Ashdene, Huddersfield; 140 16-C.P. lamps and a Crompton dynamo, for Messrs. W. and J. Whitehead, of New Lane Mills, Laisterdyke. They have also nearly completed the installation of 200 16-C.P. lamps and 1 120-ampère Mather & Platt dynamo for Messrs. Gawthorpe & Co., Marshall's Mill, Bradford.

Strike.—The Edison & Swan United Electric Light Co. have declared a lock-out at their works at Ponder's End through the action of 80 employés who came out on strike some days ago. The lock-out, we understand, has made from 300 to 400 hands idle. From paragraphs in the daily press it appears that the men, who are largely connected with the Electrical Trades' Union, are preparing for a long struggle. The object of the strikers is stated to be to force the Company to abolish what they term "the sweating piece-work system" and pay standard rates to all their employés. Our readers will remember this is not the first strike that has occurred at these works.

The General Electric Company, Limited.—This company having acquired the stock, lease, goodwill, &c., of Woodhouse and Rawson United, Limited, of Queen Victoria Street, is rapidly overhauling the stock, and reducing chaos to order, in the premises formerly occupied by the latter company. It is the intention, we understand, of the General Electric Company to open ere long their new warehouse as show-rooms for their regular goods.

The New Aluminium Works at the Falls of Foyers.—We learn from a Dundee paper that a beginning has been made with the works for the abstraction of part of the water from the river Foyers for the purpose of generating power to produce the metal aluminium from the clayey ore alumina, which is to be brought to Loch Ness from Ireland. Mr. Peregrine Birch, M.I.C.E., has designed the works, and has the superintendence of them, and Mr. A. A. Common, F.R.S., one of the directors of the British Aluminium Company, Limited, for whom the works are being constructed, was also at Foyers some days ago to see the start made. Foyers House, which was formerly a shooting box, but which has been in a ruinous condition for about a score of years, has been secured by the company for the use of workmen, and is now fitted up as a commodious lodging house with some 50 beds. It is expected that about 130 to 150 men will soon be engaged. The works now begun include the extension of the pier at Foyers in Loch Ness by 200 feet, the construction of a tunnel (half a mile in length) through rock for the conveyance of the water to a point where the fall will be made through pipes, the power thus obtained being expected to reach between 2,000 and 3,000 H.P. There will be other work to do before the production of the metal can be in progress.

The Schanschieff Electric Battery Syndicate, Limited.—A general meeting of this company will be held at 32, Poultry, E.C., at twelve o'clock noon on July 10th for the purpose of having the accounts of the Liquidator showing the manner in which the winding up has been conducted, and to transact business usual at such meetings.

W. A. Bryson v. Sir Wm. Gordon Cumming.—We understand that the action which was recently raised in the Court of Session at the instance of W. A. Bryson, consulting electrical engineer in Glasgow, against Sir William Gordon Cumming, Bart., for payment of £115, being the amount claimed for professional fees has been settled by the defender paying to the pursuer £95, and withdrawing all statements made on record affecting the pursuer's professional character or reputation.

ELECTRIC LIGHTING NOTES.

Blackburn.—The scheme for the electric lighting of Railway Road and Salford Bridge, submitted by the electrical engineer, has been referred to the Joint Lamp Sub-committee to be carried out.

Blackpool.—The order for supplying the complete electric light fittings for the Empire Palace of Varieties, now being built at Blackpool, has been secured by Messrs. Roger Dawson, Limited.

Brighton.—At a meeting of the Lighting Committee held on May 20th, the electrical engineer reported that the Corporation having decided to instal the larger Babcock and Willcox boilers, it would now be possible, and greatly to their advantage, to instal one 750 H.P. Willans steam engine, instead of two smaller ones, as at first intended. This would necessitate the lowering of the new engine room floor, to commence at the boundary of the present engine room, instead of some 20 feet further south. The Committee approved the suggestion, and instructed the surveyor to arrange for the erection of the new building accordingly.

Chester.—On the recommendation of the Electric Lighting Committee, the Council have accepted the offer of Thomas Parker, Limited, to supply the installation of electric light for £14,200, exclusive of buildings, &c., estimated at £3,000; total, £17,200, and to run it for a period of one, two, or three years, and to supply public and private lighting at the prices named, and to arrange the terms of the necessary contract, and do what may be necessary to get the installation established; and that the mayor be authorised to affix the corporate seal to such contract and any other necessary documents.

Clerkenwell.—The new Town Hall, which is to be opened to-day by Lord Rosebery, has a series of winged figures round the walls holding clusters of electric lamps. There are also gas brackets and sun burners fitted.

Dutch Guiana.—The local authorities of Paramaribo have been approached by a company with a scheme for the electric lighting of the town, and a committee has been appointed to inquire into the matter.

Eastbourne.—The Eastbourne Electric Light Company, Limited, are to extend their mains in Silverdale Road from the corner of Grassington Road to a point opposite "The Laurels," and also to lay a main for a certain distance in Carlisle Road.

Edinburgh.—The Electric Light Sub-Committee has resolved to recommend that the high tension mains should be extended to the Regent, Royal, and Carlton Terraces, to Canongate and the South Side, as suggested by the consulting engineer, Prof. Kennedy. The estimated cost is £3,500.

Electric Lighting of Barracks.—Speaking of the electric lighting of barracks, in the House of Commons on Tuesday, Mr. Campbell Bannerman said that no direct comparisons as to improved health from electric light instead of gas have, so far as he was aware, been made, although the advantages of the electric light are undoubted. Offers to supply the electric light to barracks have been made and declined, for the present, at Great Yarmouth and Dover. A succession of experiments in electric lighting has been approved, and plans for providing the light in Colchester Hospital and Cambridge Lines, Woking, are in progress.

Fareham.—In the High Court of Justice on Friday, 7th inst., judgment was given upon an appeal of the Council against a Master's decision refusing to order the company to give security for costs, and also allowing them the costs of the application. The Judge declined to disturb the Master's decision, and also refused leave to the defendants to appeal upon the question to the Court of Appeal.

Fulham.—The Electric Lighting Committee has recommended the Vestry to invite Messrs. Kincaid, Waller & Manville to furnish a report for a fee of 50 guineas on the subject of introducing the electric light with a dust destructor into the parish. The matter stands adjourned until the next meeting.

Glasgow.—We congratulate Mr. Arnot on the Council's decision to increase his salary from £350 to £450 per annum. The Committee recommended this step subject to the following conditions:—"That the whole of Mr. Arnot's time be devoted primarily to the duties connected with the Electric Lighting Department of the Gas Trust; that, in the event of an application being at any time made to the Sub-Committee on Electric Lighting by any of the other committees of the Corporation for the advice or services of Mr. Arnot in connection with any matter under the control of such committee, Mr. Arnot is, with consent of the Sub-Committee on Electric Lighting, to render such advice or service, and that the committee to whom such advice or service is given be charged therefor."

The electric light is being introduced into the Royal Princess's Theatre.

Harrogate.—Mr. Robert Hammond was recently invited to meet a committee and Mr. Wilkinson, the electrical engineer, with a view to reconsidering the whole question of system, site, and area of supply. Mr. Hammond attended, and undertook to examine and report upon the scheme adopted by the Council.

Hastings.—The Hastings and St. Leonard's Electric Light Company have made application to the Town Council for their sanction to the extension of the electric light mains. Some have been approved, but one of the proposals is considered not altogether satisfactory, and the surveyor has the matter in hand.

Holbeach.—Tenders were received by the Council for street lighting by oil, gas, and electricity. The oil tender was £140 for the season, the gas tender about £165, or 4s. 2d. per 1,000 feet consumed. The electric lighting tender was £210 per year for a period of seven years. It was decided to accept the tender of the gas company.

Ilfracombe.—At the last District Council meeting, a letter was read from Messrs. Ball & Co., asking permission to introduce the electric light. The Council decided to keep the powers in their own hands.

Islington.—A novelty introduced during the last week of the Military Tournament consisted of a search light with oil engine and dynamo combined on a light three wheeled trolly intended for field service and for flashing signals. The plant has been designed and manufactured by the Dawson Gas Engines Syndicate, Limited, the engine being one of their special high speed type, running at 800 revolutions per minute, and coupled direct to the dynamo shaft.

Kensington.—The Electric Lighting Committee reported that, having appointed a sub-committee, who had viewed the electric lighting installations at Chelsea, Ealing, St. Pancras, and Portsmouth, and carefully considered the information gained respecting the various systems in use at those and other places, they could not at present advise the adoption of the report of Messrs. Williams & King. They recommended the Vestry to advertise for complete schemes and tenders for boilers, machinery, mains, &c., necessary to carry out the work included in the compulsory area, and to refer the matter back to draw up and issue the necessary particulars and advertisements. When those are received, the Vestry to proceed to consult one or more engineers to advise thereon. These recommendations were adopted by the Vestry.

Kingstown.—A local paper says that Kingstown, in the near future, will be lighted by electricity. A company, to be named the Electricity Supply Corporation of Ireland, Limited, is in course of formation, and the Kingstown Commissioners are to be asked to approve of their intended application to the Board of Trade for a provisional order.

Lancaster.—The electric light mains are to be extended (1) from the corner of the Storey Institute along Meeting House Lane and Westbourne Road, at an estimated cost of £1,071; (2) from Queen's Square, up Lindow Street and down Regent Street, at an estimated cost of £406; (3) from the Corporation Arms, at the top of Penny Street, to the corner of Bowerham Lane, at an estimated cost of £262; (4) from the Storey Institute up Castle Hill, to the west end of Castle Park, at an estimated cost of £296. The Electricity Committee has resolved to cease to undertake private wiring, except at special request of any consumer.

London, E.C.—The Streets Committee has presented the following important report on electricity in the minor streets of the City, to the Commissioners of Sewers:—"From time to time we have had under consideration the question of lighting the minor streets of the City under the electric lighting contracts entered into by your honourable Court in the years 1890 and 1891. These contracts pro-

vide, *inter alia*, that all streets, lanes, and courts, other than those described as main thoroughfares, shall be lighted by means of 906 glow lamps, the prices being fixed at £10 per annum for lamps of 200 watts power, and £5 per annum for those of 100 watts, the right being reserved to the Commissioners to change or alter any specified lamps as they may direct. With a view to determine the best method of lighting narrow thoroughfares, experiments were made in Aldermanbury and Basinghall Street with incandescent lamps of these capacities, but the result was by no means favourable to this mode of illumination, and a subsequent trial with alternating arc lamps in the latter thoroughfare proved of no practical value. We thereupon instructed Mr. Preece and your electrical inspector to formulate a scheme for lighting the minor streets where possible by arc instead of glow lamps, and a survey of the thoroughfares in question was made, and plans were prepared by Mr. Voysey with that object. The City of London Electric Lighting Company, however, having intimated their inability to furnish us with any reliable estimate as to the cost of giving effect to the proposal until further experience has been gained on the subject, we submit a report from the electric inspector, suggesting that certain experiments should be made to illustrate side by side three different methods of illumination, whilst every facility will be afforded to Mr. Voysey by the company to check the actual cost of each system. It is proposed to light Bow Lane and the court leading out of it to Bow Churchyard by means of six sunbeam incandescent bracket lamps, so arranged as to be capable of being switched on and off by the police. Watling Street, Bread Street, Friday Street, and Old Change are to be lighted by means of 11 centrally hung arc lamps. The thoroughfares selected for the experiments being contiguous will afford the opportunity of practically testing the comparative efficiency and value of the alternating and continuous current systems of arc lighting, as well as of the method of illumination by means of Sunbeam incandescent lamps, and of obtaining information as to the respective costs of running the same, the City of London Electric Lighting Company having agreed to charge only the actual cost to them of the work, which they estimate at about £386, independently of the charge for running the lamps, which your electrical inspector is of opinion will be about £1 per night. We beg to recommend that the proposed experiments be agreed to, and that it be referred back to us to have the same carried out accordingly." Consideration of the report was postponed, and it was ordered to be printed.

London.—All Saints' Church, Margaret Street, is to be renovated, and an additional improvement is to be the substitution of electric light for gas.

Middlesbrough.—The electric lighting committee find that "the cost of an installation would be 50 per cent. more at Middlesbrough than gas, but this was counterbalanced by the greater illuminating power." They have resolved to recommend the Council to lay down an electric installation not exceeding £25,000, this being sufficient to meet the present requirements of the town.

Oldham.—The minutes of the electric lighting committee show that there had been an increase of 5,021 in the number of lights during the year. Alderman Smith pointed out at the last Council meeting that though it had been anticipated that after the first year there would have been a loss of £700 to £800, the loss actually amounted to £152 12s. 5d. The total amount expended on electric lighting in the borough now stands at £25,350. Application is to be made to the Local Government Board for the necessary powers to borrow a further sum of £15,000.

Paddington.—The Vestry are in communication with the Metropolitan Electric Supply Company, asking whether it is their intention to construct transformer boxes in the main thoroughfares, and if so, whether they have secured Parliamentary powers for the purpose.

Rangoon.—In connection with the tenders which are at present being invited for lighting the streets of Rangoon by electricity, an Indian contemporary says that underground cables must be laid within the town proper, and overhead wires in the suburban and isolated areas. At present the total cost of lighting the streets of Rangoon with kerosene lamps is Rs. 40,000 per annum, and the system is far from satisfactory. The suburbs are entirely neglected. "There should be no difficulty in obtaining at once an enterprising firm to take up the project for the above figure." The same contemporary remarks that the installation erected by the Irrawaddy Flotilla Company at the new Government House at Rangoon is, judging from the results of recent trials, quite a success. "The fittings are quite unique and automatically arranged, and the engine and dynamo are so placed that the inmates of the building will not be disturbed by the noise attendant on the working of the machinery. This success has led to the company being recommended to carry out the electric lighting of the new public offices."

Shoreditch.—The Vestry has decided, on the recommendation of the Electric Lighting Committee, to purchase the site of No. 25, Coronet Street, which projects into the Pitfield Street site, at a cost of £550.

South Africa.—We cull the following notes from the *British and South African Export Gazette*:—Tenders have been invited from German firms for the electric lighting plant for Delagoa Bay. A new electric lighting installation for the lighting of the mine and surface has been erected at the Cassel Colliery. It consists of a Goolden dynamo, with a capacity of 370 16-candle-power incandescent lights. Messrs. Reunert & Lenz have supplied the electric light to the new Standard Bank Buildings, Johannesburg. The Johannesburg Sanitary Committee have ordered a duplicate plant of boiler, engine, and dynamo, surface condenser, and switchboard. It is also proposed to obtain a third plant of the same character. Mr. W. H. Preece has recommended having a common battery of boilers for the Durban sewerage and electric lighting plants, but with separate engines. The installation would comprise 2,500 16-candle-power lamps and 60 2,000-C.P. arc lamps. Underground cables would be used in the first and central area. The cost of commencing the scheme will amount to less than £25,000. Messrs. Edlin and Stevenson, Capetown, are putting in electrical apparatus at the premises of the City Club, the Board of Executors, Messrs. Dix & Sons, Mr. H. W. Markham, Messrs. J. T. Pocock & Co., and the Royal Hotel. The current will be obtained from the municipal plant. At the Royal Hotel the installation is of 250 lights.

The New Board of Trade Regulations.—Aberdeen Gas and Electric Committee were considering the new regulations of the Board of Trade in connection with electric lighting, when objections were made to them by Mr. Blackman, electrical engineer, and Mr. Smith, gas manager. The committee decided to consult Prof. Kennedy on the points raised.

The Dundee Corporation referred the draft regulations to Mr. W. H. Brownlee, the electrical engineer, for his examination and observations. In reply, Mr. Brownlee wrote that he had no observations to make upon them further than to express the opinion that the leakage current allowed was too small. In connection with the same matter a letter has been received from the Town Clerk of Hull, suggesting that, as some of the provisions are of a grave and stringent character, concerted action should be taken by corporations with a view to securing a modification of the clauses. Meantime the whole question has been remitted to the convener of the Gas Committee.

Islington Vestry, in the person of their Town Clerk, consider one clause highly objectionable. It was to the effect that all conduits and receptacles should be so constructed as to prevent an influx of gas from the adjacent soil. If that were passed, the Vestry would be at the mercy of gas companies, instead of requiring gas companies to prevent the escape of gas from their mains into electric lighting conduits. The regulations were referred to the Electric Lighting Committee, with power to act.

Tunbridge Wells.—Plans and estimates are to be prepared by the engineer, showing how the £12,000 recently sanctioned by the Town Council for electric lighting extensions is to be expended. The cost of constructing new stations, and extending the mains along Mount Ephraim, also in Monson Road and Calverley Road, was estimated at £630 by the engineer, and it was resolved that Mr. Preece be authorised to proceed with the extensions at once.

Weybridge.—At the last Council meeting the Highways and Lighting Committee reported the receipt of "a letter from the Weybridge Electric Supply Company, Limited, inquiring whether the Council would consider the company's tender if due fulfilment of the contract were guaranteed by a firm of undoubted responsibility and repute, other than the British Thomson-Houston Company. To that the clerk was directed to reply that the Council would be pleased to have the name of the firm disclosed, but that the Council would not bind themselves to a contract for so long a period as seven years. It was also resolved to ask the company the terms upon which they would be prepared to sell their undertaking to the Council. The committee decided to ask Captain Bax for advice as to the best means of lighting the district. The committee met again on June 4th, when Captain Bax attended and reported as to the lighting of the district. It was resolved, after an amendment had been defeated, that the tender of the Weybridge Electric Supply Company be put into contract form." After a discussion the Council referred the matter back to the committee with one dissentient. The Weybridge company's offer was £3 7s. 6d. per 20 C.P. lamp per annum, and it was stated that about 250 would be required.

Wigan.—The Gas and Electric Lighting Committee do not up to the present see "quite eye to eye as to the carrying out of the electric light." At the last County Council meeting, there were expressions regarding the desirability of the matter being pushed forward.

Yarmouth.—On 6th inst. a Local Government Board inquiry was held relative to the application of the Town Council for a further loan of £17,500 on account of the electric light scheme. Mr. A. H. Preece, who was present on behalf of Mr. W. H. Preece, said that the plant was now working up to its maximum capacity, and it was absolutely necessary to increase it. £1,600 was to be spent in buildings, £1,200 for boilers, £4,800 for four steam dynamos, £3,000 for mains, £1,500 for transformers and transforming stations, £250 for switchboards, £2,000 for connecting customers and meters (250 at £8 each), and £1,000 for contingencies. The new estimate was to provide for 9,000 additional lamps to be alight at one time, and would enable the Corporation to deal with a demand for 14,000 or 15,000 lamps connected with the mains, because the lamps were never all alight at one time, the percentage in other towns varying from 50 to 80 per cent. No more arc lighting was to be provided, as no revenue was to be obtained from it.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Brighton and Rottingdean Seashore Electric Railroad.—The new Rottingdean pier erected by the company which is to work this railway was opened on June 1st. The present length is 300 feet.

Dublin Tramways.—The Rathmines and Rathgar Commissioners, on 5th inst., again discussed the question of overhead wires for the Dublin tramways. One of the speakers said "the overhead wires already erected in Leeds were most unsightly, and the authorities there refused to allow the erection of any more. Birmingham would not allow any more such wires to be erected, Blackpool would not allow overhead wires, and it was perfectly obvious that the general feeling was opposed to the system, and in favour, as an alternative, of underground wires. They did not want to prevent the advance of science, but they were anxious and determined to prevent an unsightly and a dangerous system." We should like to know upon what authority these remarks were based. Birmingham and Blackpool have never had overhead wire systems of electric traction, so they cannot very well refuse to have *more* on account of past experience, and Leeds is asking for extensions of its overhead system. These have been recommended by the Tramways Committee, as we stated a few weeks ago.

Electric Omnibuses.—It is stated that two lines of omnibuses, to be worked by electricity, will shortly start running between Hammersmith and Liverpool Street stations—one line running north of the park by Notting Hill, Bayswater, and Oxford Street; the other on the south by Kensington and Piccadilly.

Isle of Man Tramways.—A mass meeting of ratepayers was held at Douglas on 6th inst. for the purpose of considering the offer of the Tramway Company referred to by us last week. A resolution was passed in favour of the adoption of the company's proposal by the Town Board.

North Staffordshire Tramways.—At a meeting of the Longton Town Council the other day, a letter was read from the North Staffordshire Tramway Company, stating that the company had had under consideration the subject of adopting some improved form of traction, and had come to the conclusion that the only method suitable for the district in which the tram lines were laid was that of electric traction by means of overhead wires, and asking for the consent of the Council to the general principle. A deputation was appointed to meet the directors of the company and discuss the matter, and report to the committee.

Proposed Tramways in Germany.—The Berlin correspondent of the *Daily News* says that it was lately proposed by the tramway company there to introduce electric cars on the road from Berlin to Charlottenburg. The director of the Imperial Technical Institute, however, raised objections on the ground of the probable bad effect upon the instruments at the Institute. To ascertain the correctness of this assumption experiments were made, which proved that the apprehensions of the director were perfectly justified. The electric current of the railway so strongly affected all the apparatus in the Institute, that none of the more delicate scientific observations and experiments could be made. The company will, therefore, be compelled to give up the project or choose another route.

Russia and Electric Railways.—A Reuter's despatch from St. Petersburgh says that a special committee which was sent by the Russian Railway Administration to Great Britain, France, Germany, Switzerland, Holland and Belgium to study the electric railways, and latest improvements in electric transit in those countries, has just returned to Russia. M. Gortibakoff, the engineer, who is President of the Committee, has submitted a detailed report to the Emperor on electric locomotives and the English electric brake. His Majesty endorsed on the report, in his own hand, the following remark:—"Very interesting and desirable to be introduced into Russia, taking the English railways as models."

South Africa.—We understand that the United Langlaagte Company have laid down a dynamo for driving the pumps and haulage plant at the new cyanide works. Two large dynamos have been added to the plant at the New Heriot Mine.

TELEGRAPH AND TELEPHONE NOTES.

French Submarine Cables.—A despatch from Paris on 7th inst. says that strenuous efforts are being made by the French Colonial Party to force the Government to introduce an extensive system of submarine cables, in order to avoid having to depend upon the English lines in case of war, a necessity which is declared to be a great national danger. It is now stated that considerable opposition will be offered before the Budget Committee to the renewal of the subventions paid to the English cable companies, of which the principal are the Spanish Submarine Telegraph Company, 1,700,000 francs a year for the cable to Senegal, the Eastern Extension Company for Saigon and Tonquin 300,000 francs, the African Direct Telegraph Company for the West Coast of Africa 300,000 francs, and the Eastern Telegraph Company, the short line from Obock to Berlin, 37,500 francs. It is contended that this money should be devoted to founding French cable companies.

Pacific Cable.—According to the Sydney *Morning Herald*, Mr. J. S. Larke, agent for the Canadian Government, on April 30th, brought before the Chamber of Commerce at Sydney a scheme for laying a cable between Canada and Australia. The proposal is based on an arrangement that each of the three Governments shall bear a share of the responsibility. The advantages of an alternate route alone are considered to warrant the outlay, while the contingency of war, which may deprive the colonies of the advantages of other cable services that have stations on foreign soil, is held to be a very important factor in justifying the outlay. The estimated cost of laying the cable is £1,600,000. It is considered that on the credit of the three Governments the money could be borrowed at 2½ per cent. per annum. This would involve an annual charge of £40,000. Then the working expenses are put down at £24,000 per annum, the cost of management at £6,000, and for contingencies £5,000, making a total of £75,000 per annum for the first three years, during which the company contracting to lay the cable would keep it in repair. Thereafter provision is to be made for the cost of maintaining the cable at £6 per knot, amounting to £50,000 per annum, giving a total annual outlay after the third year of £125,000. Mr. Larke has made an estimate of the receipts. He bases this on a rate of 3s. per word, to begin in 1899, as compared with 4s. 9d. per word now being paid. He calculates the number of words cabled from Australia in 1899 would be 2,332,620. Granting that half the business went over the Pacific line, its share of the traffic for 1899, at 2s. per word, would be £116,631. A deduction of 8 per cent. for Press messages reduces the revenue to £107,301. Estimating increases at the rate of 5 per cent. per annum, and expenditure at the rate stated, the annual surpluses accumulated at 2 per cent. interest would by 1919 amount to £1,538,469. On this basis, all the costs of expenditure would be met, and the principal cost of laying the cable paid off by 1919. In this way the cable would be laid without cost to the Governments, and Australasia would be freed from the subsidies and guarantee, amounting in 1893 to £53,363, and be reduced to £32,400 in 1899. It is claimed that the gain to the business man would be 1s. 9d. per word on 1,948,625 words; to the Government, 1s. 6d. on 54,000 words; and to the Press, 6d. on 330,000 words. In all, to Governments, on subsidies £32,400, and on messages £4,050; to the Press, £8,250; and to business, £170,505; making a total saving of £215,205. The Chamber of Commerce has resolved to call a meeting to consider the proposal.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bedford.—June 25th. Tenders are invited by the Council for engines, boilers and armatures. For further details see our advertisement pages.

Blackburn.—July 15th. Tenders are invited for wiring the Town Hall. For further particulars see our advertisement pages.

London.—The Secretary of State for War has given notice that purchases of specific quantities of a variety of articles will probably be made from time to time during the current year. The list includes the following items:—Chain (iron, light and heavy), electrical instruments (submarine mining), India-rubber goods, lamps and lanterns, oils, spades and shovels, telegraph cable and wire. Manufacturers who may be desirous of tendering should apply to Mr. G. Lawson, Director of Army Contracts at the War Office, Pall Mall, S.W., by letter. Applications unaccompanied by references will not be noticed. Firms whose names are already on the War Office list need not apply, as forms for tendering will be sent to them in due course.

Preston.—July 1st. Tenders are invited for the wirings and fittings required for the lighting by electricity of the Town Hall and Public Hall Buildings. Particulars to be obtained from the Borough Engineer's Office, Town Hall, Preston.

Rangoon.—November 4th. The Municipal Committee is inviting tenders for electric lighting. Particulars to be obtained from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, E.C.

Roumania.—July 29th. The Municipal Authorities of Braila, Roumania, are inviting tenders for the concession for the construction and operation of an electric tramway along the main streets of the town.

Spain.—June 27th. Tenders are being invited by the Municipal Authorities of Medina del Campo, in the province of Valladolid, for the concession for the electric lighting of the town during a period of 20 years, the Municipal Authorities reserving the right to annul the concession at the end of eight years. Tenders are to be addressed to the Ayuntamiento de Medina del Campo (Valladolid).

Spain.—July 4th. Tenders are invited for the supply of 40,000 white porcelain insulators and 10,000 grey ditto. Tenders are to be directed to the Registro General, Direccion General de Correos y Telegrafos, Madrid.

Spain.—July 5th. Tenders are being invited for the supply of 25,000 zinc cylinders for Calland batteries. Tenders are to be sent to Registro General, Direccion General de Correos y Telegrafos, Madrid.

St. Helen's.—July 2nd. Tenders are invited by the Corporation for boilers, alternators, switchboards, cables, transformers, &c., &c., in connection with the proposed electric lighting of the borough.

Wakefield.—The City Council on 17th ult. decided to advertise for tenders for carrying out the electric lighting works at a cost of over £20,000.

CLOSED.

Birkenhead.—The Council on 5th inst. accepted the following tenders:—

Crompton & Co., Limited, three sets of steam dynamos, engines, feed pumps, &c.	£4,987
Do. Supply of instruments, cables, wires and other connections; also wiring and arranging the station for electric lighting, &c.	798
Tetlow Bros, Hollinwood, three Lancashire boilers	1,745
Electrical Power Storage Company, storage batteries	837
Callender's Bitumen Company, cables, wires, street boxes	4,894

It is expected that the supply will be ready by September.

Brighton.—The following tenders were sent in for the supply and erection of arc lamps, switches, &c., for the Town Council:—

Sharp & Kent, Victoria Street, Westminster ...	£2,167
Crompton & Co., Limited, Mansion House Buildings, E.C.	2,838
J. A. Edmundson, Grove Electrical Works, Leeds	2,757
Siemens Bros. & Co, Limited, Queen Anne's Gate, Westminster	2,988

Messrs. Sharp & Kent's tender was accepted. Messrs. Johnson & Phillips and the Electrical Engineering Company sent in tenders also, but these did not comply with the stated conditions.

Burton.—The Council has accepted the tender of the Telegraph Manufacturing Company, of Helsby, for the high and low pressure cables for the extension of the electric light system across the Burton Bridge and along Ashby and Alexandra Roads. The tender of the Stanton Iron Works Company for cast-iron pipes for the same works was also accepted.

Chester.—The tender of Messrs. Thos. Parker, Limited, for electric light plant, has been accepted.

Exeter.—The tender of the Electrical and General Engineering Company has been accepted for carrying out an electric lighting installation at Exeter Museum for £299 10s.

Halifax.—The tender of the Electric Construction Company, Limited, for the supply of a combined alternator and Pollit and Wigzell engine, for the sum of £3,050 has been accepted.

Hanley.—The Borough Engineer has kindly sent us the following list of the tenders which have been accepted for various contracts in connection with the electric lighting extensions by the Town Council:—

Contract No. 11.

SURFACE CONDENSING APPARATUS.

	£	s.	d.
A. Parsons & Co., Newcastle-on-Tyne	1,390	0	0
John Fowler & Co., Leeds ..	1,009	0	0
Crompton & Co., Chelmsford	895	0	0
James Watt & Co., Birmingham..	885	0	0
S. Z. de Ferranti, London ..	845	0	0
Electric Construction Co., Wolverhampton	842	0	0
Johnson & Phillips, Old Charlton	806	0	0
Siemens Bros. & Co., London	802	0	0
Brush Electrical Engineering Company, London	786	0	0
W. H. Allen & Co., Bedford (accepted conditionally) ..	755	0	0
British Thomson-Houston Co., London	740	0	0
Thomas Shore & Sons, Hanley	618	0	0

Contract No. 12.

TWO LANCASHIRE BOILERS, &c.

	£	s.	d.
Davy Brothers, Ltd., Sheffield	1,718	0	0
Daniel Adamson & Co., Dukinfield..	1,645	0	0
Hawksley, Wild & Co., Sheffield	1,450	0	0
Tinkers, Limited, Hyde ..	1,400	0	0
Joseph Adamson & Co., Hyde	1,360	0	0
John Thompson, Wolverhampton	1,350	0	0
Brush Electrical Engineering Company, Limited	1,298	0	0
W. R. Renshaw & Co., Stoke-on-Trent	1,180	0	0
Edwin Danks, Oldbury (accepted conditionally) ..	1,178	0	0
H. and T. Danks, Ltd., Dudley	1,000	0	0

Contract No. 13.

WATER TANK, &c.

	£	s.	d.
Peirson & Co.	438	0	0
Brush Electrical Engineering Company	243	0	0
Cowlishaw, Walker & Co. ..	225	0	0
Edwin Danks	205	0	0
Cochrane & Co.	185	0	0
John Warner and Sons.. ..	180	0	0
Thomas Shore and Sons ..	170	0	0
John Thompson	167	10	0
W. R. Renshaw & Co. (accepted)	164	18	0

Contract No. 14.

ARC LAMPS AND POSTS.

The tenders and designs received demand more time for consideration and are consequently deferred to the next meeting of the Council.

Contract No. 15.

ELECTRIC LIGHT MAINS.

HIGH AND LOW TENSION CURRENTS.

	£	s.	d.
Laing, Wharton and Down ..	2,084	10	0
Brush Electrical Engineering Company	1,757	10	10
W. T. Glover & Co.	1,696	10	4
W. T. Henley's Company	1,695	3	6
India-Rubber and Gutta Percha Company	1,657	17	0
Siemens Bros. & Co.	1,609	5	10
Fowler-Waring Cables Co.	1,525	19	0
Telegraph Manufacturing Co. ..	1,521	12	0
Johnson and Phillips	1,509	18	4
British Insulated Wire Company (accepted)	1,398	8	4

The same but including Kingdon's Patent Wrought Iron Cover.

W. R. Renshaw & Co.	2,290	6	8

Low Tension Mains only, including laying.

Callender's Bitumen, &c., Co. ..	1,780	13	4

For 2-inch Cast-Iron Pipes.

The Stanton Iron Company (accepted).. .. .. at per ton	4	12	6

Contract No. 16.

TRANSFORMERS WITH HIGH AND LOW TENSION SWITCHES.

	£	s.	d.
C. A. Parsons & Co.	888	0	0
Siemens Bros. & Co.	823	0	0
Johnson & Phillips	738	0	0
Electric Construction Co.	694	10	0
Crompton & Co.	675	0	0
Brush Electrical Engineering Co. (accepted)	662	2	0
John Fowler & Co.	623	8	0

Lancaster.—The Corporation has resolved to accept the tender of Messrs. Callender's Bitumen Company for three-way casings and cables at £366 per 1,000 yards.

Shoreditch.—We understand that a large number of tenders were sent in for the wiring of the Town Hall, ranging from £845 to £178, the lowest being that of the Electrical and General Engineering Company, who have received the contract.

Worcester.—The Public Library Committee the other day decided to accept the tender of the New British Installation Company (a local firm) for £786 for the electric lighting of the Victoria Institute.

INAUGURATION OF THE GOVERNMENT TRUNK TELEPHONE LINES.

WHAT may be called the "Telephone" policy of the Government took definite shape in 1892. In that year, the terms of the agreement with the National Telephone Company and its allied undertakings, were settled by the late Administration. Under this agreement, as is well known, the operations of the company were to be confined to the purely local exchange work in towns and defined areas, while the Government reserved to itself the right to work all the trunk lines connecting these towns and areas with each other.

For the acquisition of the existing trunk lines of the companies, and the provision of a "backbone" system of heavy wires, with the necessary spur lines connecting all the chief towns of England, Scotland, and Ireland together, Parliament provided, by the Telegraph Act of 1892, the sum of £1,000,000.

The mileage and weight of the wires comprising this system are as follows:—

2,719 miles of copper wire ...		800 lbs. to the mile.
4,914 " " ...		600 " "
2,646 " " ...		400 " "
96 " " ...		in a four-wire submarine cable, 24 miles long.
Total length of wire ...	...	10,375 miles.
Total weight of copper ...	...	2,829 tons.

The mileage actually completed to date is 7,595 miles. All the circuits are metallic loops.

The wires centre on Leeds, which will be telephonically the heart of the kingdom. It will be the main switching station for the Post Office trunk wire system.

On Wednesday last a formal inauguration of the new service was held at the General Post Office. The wires from the North were led into the new Post Office building, and a distinguished party of gentlemen conversed with the various towns along the route. Among those present were Mr. Arnold Morley (Postmaster-General), the Lord Mayor of London, several members of the Select Telephone Committee of the House of Commons, including Sir Charles Cameron, Mr. T. Snape, and Mr. J. W. Benn; Lord Kelvin, Mr. J. S. Forbes (President of the National Telephone Company), Mr. J. C. Lamb, C.B., Mr. W. H. Preece, C.B., and other prominent officials of the Post Office. Congratulatory conversations passed between the Postmaster-General and the Lord Mayor at the London end, and the Lord Provosts of Edinburgh and Glasgow, the Lord Mayor of Dublin, the mayors and other civic dignitaries of Nottingham, Derby, &c., and a number of other prominent citizens in these and other chief towns along the route. Speech was excellent in all cases, conversation being easily maintained even to Dublin, in the ordinary natural tone of voice.

In the evening of the same day the new lines were introduced to the scientific world at the Royal Society *soirée*, connections being made to Burlington House for the occasion. Two circuits were connected up, viz., those to Glasgow and thence to Edinburgh, and to Dublin and Belfast *viâ* Carlisle and Stranraer. In addition to conversation, vocal and instrumental music was rendered at all four towns to which connection was made. From Belfast some excellent selections from the violin, voice, and piano, were conveyed to the ears of the delighted listeners at Burlington House. Edinburgh provided songs and cornet solos. True Irish melody came over the lines from far off Dublin; and Glasgow, in addition to some capital cornet playing and singing, brought down the house with pibroch and reel from the wailing bagpipes. The experiments were most successful and charming in every way. Receivers were so connected to the lines, that six or eight persons could listen at each circuit simultaneously. Among those who tested the circuits were Lord Kelvin, Lord Rayleigh, Prof. Bryce, M.P. (President of the Board of Trade), Prof. Hughes, Sir Douglas Galton, and Prof. Silvanus Thompson.

The instruments used at all stations were the double-pole Bell receiver and the Deckert transmitter. The latter is an Austrian instrument, of the granular form, and is an improvement on the well-known Hunnings transmitter. It has been tested most carefully by the Post Office technical staff, and for general all round efficiency has been found superior to all other transmitters that have been tried.

The lines are built according to the K R law, familiarised to the scientific world by Mr. Preece. The total capacity (K) into the total resistance (R) of the line determines its value as a means of conveying speech by telephone. The product (K R) referred to a constant, indicates whether speech will be excellent, good, fair, or poor. The applicability of this law to the problem to be solved has been questioned, especially by American telephone engineers. But it is not now necessary to discuss the correctness of the law. It is enough to say that the telephone lines built by the British Post Office have proved a great success telephonically. From the practical point of view, therefore, the K R law comes out all right; as our American cousins would say, "There are no flies there." It remains to be seen whether the new means of communication will be made sufficient use of by the public to enable a commercial success to be registered, in addition to the scientific and engineering success that has been assured.

The rates for conversation on these new trunk lines will be:—

Up to 20 miles	3d. per talk.
Up to 40 miles	6d. ,,
Each 40 miles, or part of 40 miles, additional	6d. ,,

Conversations in all cases mean the use of the wires for three minutes.

Some of the principal rates are:—

London to Edinburgh	4s. 6d.	per talk.
,, Glasgow	4s. 6d.	,,
,, Dublin	7s. 6d.	,,
,, Cardiff	2s. 0d.	,,
,, Plymouth	2s. 6d.	,,

The circuits will very shortly be open for public traffic.

NOTES.

The Electrical Standardising Institution.—It is some two or three years ago that we first experienced the pleasure of meeting at dinner the students of the Electrical Standardising, Testing, &c., Institution. We were then so much impressed that we sincerely hoped that the gatherings would become an annual necessity. As far as we know, however, the resumption of these meetings did not take place till the evening of Thursday last week, when the students along with many distinguished guests assembled to do honour to the existence of Faraday House. Lord Castletown, of Upper Ossory, had intended to take the chair, but was unfortunately prevented by family bereavement from being present. Mr. Robert Hammond, however, filled the position admirably, and as the founder of the excellent institution, was able to give some interesting account of the reasons which led him to commence the training of electrical engineers. It is scarcely necessary to say that Mr. Hammond was one of the very earliest to apply the electric light to practical purposes, and the difficulties that he experienced in obtaining suitable engineers led him to conceive the idea of making them. It is the gathering of Thursday week, however, which concerns us for the moment. No more fitting place than the Imperial Institute could have been selected as a venue for the gathering. The arrangements for the function of the evening, to wit the dinner, were as good as anything we have ever experienced. The cuisine would have called forth the eulogiums of a Sala, while the decorations both of the hall and the table were pleasing in the extreme. The speeches, also, were excellent, and we regret that the want of space precludes us from recording them. Colonel Gouraud in the happiest manner proposed the toast of the Institution, which was responded to by Mr. Hammond. Mr. Francis Ince proposed the Visitors, and Judge Snagge replied. The chairman proposed the "The Past and Present Students," which was answered by Mr. Stothert, a past student, and Mr. Gladstone, a present student; while Sir Courtney Boyle submitted the toast of the Board of Control and Staff, which was acknowledged by Mr. Francis Ince and Mr. Hugh Erat Harrison, the Principal. One of the most noteworthy utterances of the evening, and one which shows the real strength of the Institution, was that 80 per cent. of the pupils had been placed in works.

Prof. Thomson's Carbon Brush for Low Potential Machines.—While carbon brushes have proved eminently successful for high potential machines, they have not been shown to be so satisfactory for the ordinary low potentials of 110 volts and under. This, of course, is largely due to the heat generated in the carbons by the heavy currents, and the additional pressure required to get a good contact. One of the methods of overcoming this difficulty, employed in the past, has been to mix with the carbon a more or less conducting material. Recently, however, according to the New York *Electrical Engineer*, Prof. Elihu Thomson has devised another method. Instead of employing a solid block, use is made of a number of small rods of carbon plated with a thin film of copper. These rods are assembled in the form required, and of the required size, so as to give the desired thickness, length, and width of the brush, and the copper plated carbon pieces are united by soldering, that is, by "sweating in" solder between them in a sufficient number of places to hold them together. The carbon surface applied to the commutator is broken away into facets, and the current which is taken from the commutator through the carbon faces is at once delivered to the metal which unites the various carbon pieces, and is conducted through the body of the brush by the metal chiefly. The metal is so thin that the moment it touches the commutator at any point, the extra conductivity causes it to shunt enough current to disintegrate it at once, so that at all times the carbon surfaces take the wear, and the metal is eaten away a short distance as rapidly as the carbon is presented. This method of construction also permits of the conductivity of the brush being varied to suit the current to be taken up, and the potential of the dynamo will determine the amount of the metal which is to be used relatively to the carbon; that is, by plating the pieces more heavily, the conductivity can be raised between limits, and by putting the merest film of metal on the carbon pieces, it can be lowered.

Cost of Electricity with Gas Plant.—Anything relating to the cost of electric energy when using gas engines is of supreme importance at the moment. Some recent tests that have been made of a private electric lighting plant in use at "Olympia," Newcastle-on-Tyne, afford abundant testimony to the economy of this type of engine. The plant, which was supplied and erected by Messrs. Rowland, Barnett & Co., consists of a 38 I.H.P. gas engine and a 16 kw. dynamo. Mr. Thomas Hanning, A.M.I.C.E., tested the combination on three successive days, and the engine and dynamo was found to have a combined efficiency of 69 per cent. at full load. The following table sets forth the cost per kilowatt hour, and it will be found that the working has been singularly economical:—

Actual cost of working above plant for one year of 1,000 hours.
Cost of plant, £700.

	£	s.	d.
Interest and depreciation, 10 per cent. on £700	70	0	0
Oil and waste—52 weeks at 2s. 6d. per week	6	10	0
Cost of 660,000 cubic feet, at 1s. 8d. per 1,000	55	0	0
Attendant—1,200 hours, at 5d. per hour	25	0	0
Lamp renewals and carbons for three arc lamps	13	10	0
Total cost per annum of 1,000 hours ...	£170	0	0

Total cost per unit generated 2·55 pence.

	Pence.
Total cost of gas per unit generated	·825
,, interest and depreciation per unit generated ...	1·05
,, labour per unit generated	·375
,, lamp renewals and carbons per unit generated	·2025
,, oil and waste per unit generated	·0975
Total cost per unit generated	2·5500

Total cost per 16 C.P. lamp per hour = ·1275 of a penny.
Candle-power per cubic foot of gas used = 8.

To Those Whom it May Concern.—The *Western Electrician* believes that we underrate the intelligence of our readers even if they are English, and speaks of enlightening British obtuseness. No one, however, can accuse us of overrating the scientific qualifications of certain of our American contemporaries. We need only refer to the Boynton "multivolt" battery, to a note on page 685 of our issue of May 31st, and to page 484 of the New York *Electrical Engineer* for May 29th.

Street Car Speeds.—As was to be expected, says the New York *Electrical Engineer*, many citizens of Brooklyn are now annoyed at the slow speed of the street cars, and want them faster; while, on the other hand, the agitators responsible for the regulations say they can get 200,000 petitioners in favour of the lower speed. It seems to us that the whole case is on a wrong basis, and we venture to take the following little item as a text:—

A cable car was rapidly going west in 125th street about eleven o'clock last night when two wheelmen, Charles Ransom, of No. 372, Alexander Avenue, and Walter Rogers, of No. 481, East 125th Street, tried to get before it at Manhattan Avenue. Ransom succeeded, but as Rogers reached the track some obstacle pierced his bicycle's pneumatic tire, the result being that he was thrown from the wheel. He fell in the middle of the track, but the gripman saw him in time to bring his car to a standstill *a foot away from the young man's head.* Rogers, who was stunned, was carried into a neighbouring drug store, and a doctor who was summoned found that his nose was broken and his scalp badly lacerated, and it was thought he was injured internally. He would not hear of going to a hospital, however, so his friend called a carriage and in that he was taken home.

Now, it is well known that these cable cars are equipped with the Genett air brake—and not the later, better form of it, either. If Brooklyn will only insist on its trolley cars having such a brake, its modern citizens can have cars just as fast as they need them, and its 200,000 sleepy antiquated citizens who have hitherto objected, can still stay on the track as long as they like, with impunity. The air brake on all street car lines is as inevitable as it has proved to be on steam railroads, and we have no doubt that within a very few years, every car in every city will have it, either adopted voluntarily or enforced by legislation.

Electricity in Tin-Plate Manufacture.—Writing to the *Engineer*, Mr. W. Stepney Rawson, M.I.E.E., says: "I note in your number of the 24th inst. a reference to the application of an electrical current to pickling tin-plates. It would appear as if our American friends had stolen a march on us again, and that a revolution is at hand in the galvanising and tinning trades of England; but on closer examination I find that, unless I am mistaken, the inventor of the process described by your commissioner hails from the Midlands. Why did he not stay at home and make his fortune? A saving of 75 per cent. of acid would soon amount to a very large sum. I think, however, that unless there is a serious omission in your description, it is easy to detect an old friend in this process. The Patent Office is full of similar attempts. It does not work, because (1) iron cannot be deposited in a solution unless it is almost quite neutral; (2) in such a solution the oxide on the surface of the anode plate cannot be dissolved by further oxidation, which is all that takes place by the action of the current. Electricity can be, and is, being advantageously applied to pickling, but not on the principle described in your article. The chemistry of the question makes it impracticable, even leaving out of the question the difficulty of making equally good connection to each one of 1,000 plates in a single batch, which, in practice, occupies about 7 minutes to pickle in the acid. I shall be only too glad to hear that such a result as is claimed has been obtained, because I know well the enormous improvement that it would make in the conditions under which many trades are carried on; but something other than the exploded idea described in your commissioner's article will have to underlie the method."

The Highest and the Lowest.—If a great error has not been made somewhere, the tenders for lighting the Shoreditch Town Hall, which are recorded under our "Contracts Closed," show an extraordinary and unaccountable divergence. We derive the information solely from local papers, our application to the Vestry Clerk having called forth no reply. It will be seen that the highest tender amounted to £845, while the lowest, which was accepted by the Vestry, amounted to £178. In one journal, we note, that the consulting engineer who drew up the specification, computed that the work would cost about £750. In the interests of the Vestry and of electrical work generally we trust that some explanation will be made.

The Support of Home Industries.—The evidence which Mr. Staats Forbes, the president of the National Telephone Company, laid before the Parliamentary Committee, was admirable, both in tone and character, but there were one or two statements which required more explanation than was afforded. We do not desire to take any advantage of the obviously difficult position which Mr. Forbes held in the recent enquiry. He desired to give clear and weighty evidence without handing the secrets of the company over to the enemy. In this Mr. Forbes mostly succeeded, but it will be seen from the correspondence which appeared in our last number, and from that appearing in the present issue, that one of his statements is being seriously challenged. It may be remembered that in our issue of May 31st, we called the attention of English wire makers to a remark of Mr. Forbes that the National Telephone Company were obliged to go to Germany for the best wire. Judging from the letters of Messrs. Bolton & Sons and Messrs. Frederick Smith & Co., there was apparently little reason for the sentimental and patriotic regret of Mr. Forbes. It would, we think, be very difficult to establish the fact that English copper wire was inferior to that made in Germany, but perhaps there was another factor in the case, that of cheapness. To buy in the cheapest market cannot be considered a very serious offence, and no doubt the National Telephone Company like to obtain the benefits of competition with none of the evils.

Dr. W. G. Grace.—Science is naturally not made a strong feature of the *Daily Telegraph*, but when any movement of interest to the nation is on foot, our contemporary, with the largest circulation in the world, is always to the fore. At the present moment, amongst all sorts and conditions of men (and women), W. G. Grace is the one theme of conversation; politics, art, music, the Shahzada, even electricity are all for the moment absolutely eclipsed. Probably in no section of the sport-loving public can greater enthusiasts be found than amongst the electrical fraternity; therefore we have no hesitation in suggesting that one and all should send in their shilling, or shillings, to the *Daily Telegraph* National Shilling Testimonial to Dr. W. G. Grace. To no one more than to the professional man does the desire to see his offspring grow up with a full sense of everything that constitutes true manliness appeal, and to W. G. Grace, more than to any other living being, do we owe a debt of gratitude for showing the youth of the past three decades the true meaning of *mens sana in corpore sano.* He is the Bayard, *sans peur et sans reproche*, of our national game.

Objections to the Board of Trade Regulations.—Objections or suggested alterations to the proposed rules and regulations of the Board of Trade have to be lodged by 16th inst.

Telephone Litigation in America.—The Berliner patent which was annulled by one Court, has now been sustained by the United States Circuit Court of Appeals. A further appeal will be made to the Supreme Court.

The Shahzada.—The Shahzada paid a visit to the Liverpool Overhead Railway on Wednesday, and so interested and amazed was he that the trains were worked without a visible force, that he intends again inspecting it.

Errata—Corrige.—A recently published Italian book on "Magnetismo ed Elettricità," published by Ulrico Hoepli, Milan, is distinctly humorous. Its errata-corrige corrects Maxwel by Maxvell.

NEW COMPANIES REGISTERED.

Connolly Bros., Limited (44,277).—This company was registered on June 1st with a capital of £20,000 in £5 shares, to acquire, take over as a going concern, and carry on the business of insulated cable manufacturers and electricians, carried on at Blackley Vale Mills, Blackley, Lancashire, by J. T. Connolly and J. Connolly as Connolly Bros., and to adopt a certain agreement. The subscribers are (with one share each):—J. T. Connolly, Vale Mills, Blackley, electrical engineer; J. Connolly, Vale Mills, Blackley, electrical engineer; T. Connolly, Eastwood, Clayton Bridge, engineer; L. Frankenstein, 33, Miller Street, Manchester, manufacturer; Mrs. E.

Connolly, Eastwood, Clayton Bridge; W. Connolly, Eastwood, Clayton Bridge, engineer; J. H. Peters, 62, King Street, Manchester, solicitor. The number of directors is not to be less than two nor more than four; the first are John T. Connolly and James Connolly; qualification, £100; remuneration as fixed by the company in general meeting. Registered office, Blackley Vale Mills, Blackley, Lancashire.

CITY NOTES.

West Coast of America Telegraph Company.

Mr. J. Denison Pender, at the meeting of this company on Wednesday, had to relate a gloomy history of the company for the year 1894. To be compelled to take £10,400 from the reserve fund in order to pay debenture coupons is not estimated to have an encouraging influence on directors or shareholders. In the light of the previous report, however, the shareholders seemed to have been prepared for the worst, for the meeting dispersed without a murmur. Unsatisfactory as was the position of the company at December 31st, 1894, there is much consolation in the fact that the state of affairs when compared with December 31st, 1893, has markedly improved, and things are much brighter than they were. The traffic receipts for the year showed an increase of £8,057, and the interest account a decrease of £1,401, the latter arising through reducing the reserve fund. The gross receipts showed £6,657 in excess of 1893. The revenue derived from the Pacific and European Telegraph Company is very satisfactory. Local traffic of the West Coast Company exceeded that of the previous year by 250,000 words; but the reduction in the rate from 14d. in 1893 to 12d. in 1894 had prevented them from gaining any cash increase from it. Fluctuations in exchange entirely upset any calculations made last year, for they looked for an increase of revenue from local traffic. Nearly all the expenses had to be paid in sterling, whereas they collected in currency. After going into various other details, the chairman referred to the speed of messages conducted over their lines on Derby Day. The result of the race was posted up at the company's office in Valparaiso three minutes after it was known at Epsom. In regard to the outlook for the future Mr. Pender would not attempt to prophesy. At the present moment he believed they were paying all their expenses, including debenture interest, without having to encroach upon the reserve. The board continued hopeful as to the future. However, the present better state of affairs might not continue, so they must not interpret what he said as a statement that 1895 would be much more satisfactory. He, however, hoped and trusted it would.

Mr. Walters seconded the adoption of the report, which was unanimously carried. The retiring directors and auditor having been re-elected, a vote of thanks to the directors and staff was replied to by the chairman.

Woodhouse & Rawson United, Limited.

Mr. C. J. Stewart, the official receiver and liquidator of this company, issued the following circular on May 31st, 1895:—

"A meeting of the 6 per cent. debenture-holders and 5½ per cent. and 10 per cent. debenture stockholders of the above-named company will, by direction of Mr. Justice Vaughan Williams, be held at the Cannon Street Hotel, Cannon Street, London, E.C., on Thursday, the 13th day of June next, at half-past eleven o'clock in the forenoon, for the purpose of considering, and, if thought advisable, of authorising the employment of the funds of the debenture-holders upon legal proceedings against the directors and auditors of the company by the official receiver and liquidator, for the recovery of moneys which counsel have advised that such directors and auditors are liable to refund.

"Mr. Justice Vaughan Williams further directed that there should be one meeting for all classes of debenture-holders, but that, if necessary, a vote of each class shall be separately taken.

"As the matter is of considerable importance, you are particularly requested to attend in person, or to depute in writing some other person to represent your interests at the said meeting.

"C. J. Stewart,
"*Official Receiver and Liquidator.*"

The meeting was held yesterday, and adjourned until next Wednesday at 11.30 at Carey Street, W.C.

Hobart (Tasmania) Electric Tramway Company.

The second general meeting of this company was held at the offices, College Hill Chambers, Cannon Street, on Tuesday, under the presidency of Dr. Alfred Mattei, who stated that during the year they had carried 2,478,938 passengers, and had run 584,117 car miles, and their latest advices reported that for the month of April they had reduced their working cost to 6½d. per car mile. The board were doing all in their power to reduce expenditure. The standing item of interest upon the first and second mortgage debentures could not, of course, be reduced. The line was being worked more cheaply than formerly, for there they were now doing the work themselves, instead of putting it out to contract, which was necessary in the first instance. Their revenue, taking everything into consideration, was satisfactory. Tasmania, in common with the rest of Australia, had gone through a great crisis, and they had suffered with the rest. Not only had people travelled less for necessity, but the pleasure traffic had also fallen off. It would be seen that they had increased their second mortgage bonds by £5,000, and these bonds now stood at £20,000, making, with the £30,000 of first mortgage bonds, a total of £50,000. With this £5,000 they had settled the liability of Messrs. Siemens Brothers and Co. of £3,400, and the vendors £500, leaving a small balance in hand. He believed that their next balance-sheet would compare favourably with the present one. They had not lost sight of their project of lighting Hobart by electricity, but he could not say more upon the subject at the moment. Their outlook was encouraging. The report was adopted.

Chatham, Rochester, and District Electric Lighting Company.

The annual meeting of this company was held on Thursday last week, at the Sun Hotel, Chatham, Mr. H. Jasper presiding. It was resolved that a dividend of 2½ per cent. be paid out of net profits in accordance with the recommendation of the directors in their report, which showed that the profit of the year on the generation of electric energy and installations had been £456 13s. 6d., and as there was every indication that the company would continue to earn greater profits, they proposed the payment of this dividend, carrying forward £396 6s. 5d. The chairman stated that to large consumers, to whom a large discount was given, the price charged for the current was only equal to gas at 1s. 11½d. per 1,000 feet.

Elmore's German and Austro-Hungarian Metal Company, Limited.

At the fourth annual meeting of this company, held on Wednesday at Winchester House, Mr. John MacFarlan, the chairman, said: The loss on trading account was practically *nil*. From January 1st to June 8th—that is, to Saturday last—the weight of goods sold amounted to 63½ tons, as against 22 tons for the same period last year, or, roughly, three times as much. This was a great advance, and one that should continue and even increase with greater rapidity. Although the price of copper had been low—in fact, the lowest on record—their prices have remained high, averaging £98 to £100 per ton. During the 23 weeks ended Saturday last they had received 397 orders, as against 579 orders during the whole of last year, and customers had increased from 243 on December 31st last to 309 on the 8th inst. They had this year introduced a new article made by the Elmore process, which was likely to monopolise the market. It was a copper condenser cover for torpedo boats, and they had already supplied several to the Government contractors in Germany. The new plant was giving great satisfaction, and upon it being found successful they at once spent a considerable sum of money in altering and improving the old plant, and they were pleased to state that this is now as complete as that erected last year. They had worked hard to overcome their troubles, and he could only say that they were now commencing to be repaid.

After some discussion the report was adopted.

Electric and General Investment Company.—The directors have decided to recommend to the shareholders the payment of a further dividend on the capital paid up on the ordinary shares at the rate of 30 per cent. per annum for the six months ended May 31st last, making, with the interim dividend already paid, a total dividend of 20 per cent. for the year, and also to make a distribution of £35 16s. on each founder's share for the year. The transfer books will be closed from June 19th to July 2nd, both days inclusive, for the purpose of preparing the dividend warrants.

Telegraph Manufacturing Company, Limited.—We are informed that the ninth ordinary general meeting of this company was held last Friday, and the usual distribution of profits was declared, viz., a dividend of 5 per cent., and, in addition a bonus of 2½ per cent., both free of income tax.

National Telephone Company, Limited.—The transfer books of the 3½ per cent. debenture stock will be closed from 17th to 29th inst., inclusive, for the preparation of warrants for the half-year's interest, due July 1st.

Metropolitan Electric Supply Company, Limited.—The transfer books of the 4½ per cent. first mortgage debenture stock will be closed from 17th to 30th inst., both days inclusive, for the purpose of preparing interest warrants.

Commercial Cable Company.—A quarterly dividend at the rate of 7 per cent. per annum has been declared by the directors, payable on July 1st.

The Phonopore Company, Limited.—The transfer books will be closed until the 27th inst.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending June 9th, 1895, **amounted to £904; week ending** June 10th, 1894, £911; decrease, £7; total receipts for **half-year, 1895, £21,437;** corresponding period, 1894, £20,924; increase, £513.

The Great Northern Telegraph Company. The traffic receipts in May, 1895, were £28,400; January 1st to May 31st, 1895, £124,000; corresponding months, 1894, £105,300; corresponding months, 1893, £103,000.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending June 9th, 1895, amounted to £1,671; corresponding week last year, £843; increase £828.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 7th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,650.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, June 5th.	Closing Quotation June 12th.	Business done during week ended June 12th, 1895. Highest.	Lowest
173,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	102 —105	103 —105	104$\frac{3}{4}$	...
1,012,880*l*	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	46 — 48	46 — 48	46$\frac{1}{4}$	46
2,993,560*l*	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	84$\frac{1}{2}$— 85$\frac{1}{2}$	84$\frac{1}{2}$— 85$\frac{1}{2}$	85$\frac{1}{2}$	84$\frac{1}{2}$
2,993,560*l*	Do. do. Defd.	Stock	...	...	...	8$\frac{1}{4}$— 8$\frac{3}{4}$	8$\frac{1}{4}$— 8$\frac{3}{4}$	...	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6$\frac{1}{2}$% §	6$\frac{1}{2}$% §	...	13 — 13$\frac{1}{2}$	13 — 13$\frac{1}{2}$	13$\frac{1}{2}$	13$\frac{1}{4}$
75,000*l*	Do. do. 5 %, repayable June 1906	100	5 %	5 %	...	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	10%‖ §	... §	...	3 — 4	3 — 4	3$\frac{9}{16}$	3$\frac{1}{2}$
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	154 —158	154 —158	160	...
224,850	Consolidated Telep. Const. and Main., Ltd. ...	10/-	2 % §	2 % §	1$\frac{1}{2}$%	$\frac{1}{16}$— $\frac{3}{16}$	$\frac{1}{16}$— $\frac{3}{16}$xd	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4 %	4 %	4 %	3$\frac{1}{2}$— 4$\frac{1}{2}$	3$\frac{1}{2}$— 4$\frac{1}{2}$	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9$\frac{3}{4}$— 10$\frac{1}{4}$	9$\frac{3}{4}$— 10$\frac{1}{4}$	...	...
30,000*l*	Do. do. 4$\frac{1}{2}$ % Debs of £50, Nos. 1 to 1,600	...	...	...	4$\frac{1}{2}$%	105 —108%	105 —108%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3$\frac{1}{2}$% §	2$\frac{3}{4}$% §	2 %	9$\frac{1}{4}$— 9$\frac{3}{4}$	9$\frac{1}{4}$— 9$\frac{3}{4}$	9$\frac{3}{4}$	9$\frac{1}{4}$
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6$\frac{1}{2}$% §	6$\frac{1}{2}$% §	...	16$\frac{1}{2}$— 16$\frac{3}{4}$	16$\frac{1}{2}$— 16$\frac{3}{4}$	16$\frac{7}{8}$	16$\frac{1}{2}$
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	17$\frac{1}{4}$— 17$\frac{3}{4}$	17$\frac{1}{4}$— 17$\frac{3}{4}$	17$\frac{7}{8}$	17$\frac{1}{4}$
102,100*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	106 —109	105 —109	..	...
1,297,837*l*	Do. 4 % Mort. Deb.	Stock	4 %	4 %	.	123 —126	123 —126	125	123$\frac{3}{4}$
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	16$\frac{7}{8}$— 17$\frac{1}{8}$	16$\frac{7}{8}$— 17$\frac{1}{8}$	17$\frac{1}{8}$	16$\frac{7}{8}$
54,100*l*	{ Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	5 %	5 %	5 %	104 —108	104 —108	...	...
194,300*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	105 —108	105 —108	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	124 —127	124 —127	...	...
80,600*l*	{ Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343 }	100	5 %	5 %	5 %	104 —108	104 —108	...	...
107,600*l*	Do. do. do. to bearer, 2,344 to 5,500	...	5 %	5 %	5 %	105 —108	105 —108	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	4 %	4 %	4 %	107 —110	107 —110	107$\frac{1}{2}$	107
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	111 —114%	111 —114%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4$\frac{7}{8}$% §	4$\frac{8}{8}$% §	...	10 — 10$\frac{1}{4}$	10 — 10$\frac{1}{4}$	10$\frac{3}{16}$	10$\frac{1}{16}$
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	...	16$\frac{7}{8}$— 17$\frac{1}{8}$	16$\frac{3}{4}$— 17	17	16$\frac{3}{4}$
150,000	Great Northern Teleg. Company of Copenhagen	10	8$\frac{3}{8}$% §	8$\frac{3}{8}$%	8$\frac{3}{8}$%	22 — 22$\frac{1}{2}$	22 — 22$\frac{1}{2}$	22	...
180,000*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	105 —108	105 —108	105$\frac{1}{4}$	106
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	44 — 47	44 — 47	46	45
37,548	London Platino-Brazilian Teleg., Ltd.	10	2 %	2$\frac{1}{2}$%	1$\frac{1}{4}$%	5 — 7	5 — 7	...	...
100,000*l*	Do. do. 6 % Debs.	100	6 %	6 %	6 %	106 —110	106 —110	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	... — ...	... — ...	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	*nil*	4 %	...	1$\frac{1}{4}$— 2$\frac{1}{4}$	1$\frac{1}{4}$— 2$\frac{1}{4}$	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	5 % §	5 % §	5 %	5$\frac{3}{8}$— 5$\frac{5}{8}$	5$\frac{1}{4}$— 5$\frac{3}{4}$	5$\frac{3}{4}$	5$\frac{9}{16}$
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	15$\frac{1}{2}$— 16$\frac{1}{2}$	15$\frac{1}{2}$— 16$\frac{1}{2}$	16$\frac{1}{4}$	16
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	14$\frac{1}{2}$— 15$\frac{1}{2}$	14$\frac{1}{2}$— 15$\frac{1}{2}$	15$\frac{3}{8}$	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	5 %	5 %	...	5$\frac{7}{8}$— 6$\frac{1}{8}$	5$\frac{7}{8}$— 6$\frac{1}{8}$	6	5$\frac{7}{8}$
1,100,000*l*	Do. 3$\frac{1}{2}$ % Deb. Stock Red.	...	3$\frac{1}{2}$%	3$\frac{1}{2}$%	...	104 —106	104 —106	105$\frac{1}{2}$	105
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4$\frac{1}{2}$%	$\frac{9}{16}$— $\frac{11}{16}$	$\frac{9}{16}$— $\frac{11}{16}$	...	...
100,000*l*	Pacific and European Tel., Ltd 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	106 —109	106 —109	108	..
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	3$\frac{1}{2}$— 4$\frac{1}{2}$	3$\frac{1}{2}$— 4$\frac{1}{2}$	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	123 —128	124 —129	127$\frac{1}{2}$	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1$\frac{1}{2}$— 2$\frac{1}{2}$	1$\frac{1}{2}$— 2$\frac{1}{2}$	1$\frac{3}{4}$	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	87 — 92	87 — 92	...	..
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	...	...	4$\frac{1}{2}$— 5$\frac{1}{2}$	4$\frac{1}{2}$— 5$\frac{1}{2}$	...	...
238,300*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	...	102 —105	102 —105	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1$\frac{1}{2}$— 2$\frac{1}{2}$	1$\frac{1}{2}$— 2$\frac{1}{2}$	2$\frac{3}{16}$	1$\frac{3}{4}$
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	100 —105	100 —105	100$\frac{3}{4}$	...
64,245	Western and Brazilian Teleg., Ltd.	15	2$\frac{1}{2}$%	2$\frac{1}{2}$%	3 %	10$\frac{1}{4}$— 10$\frac{3}{4}$	10$\frac{1}{4}$— 10$\frac{3}{4}$	10$\frac{3}{4}$	10$\frac{1}{4}$
33,129	Do. do. do. 5 % Pref. Ord. ...	7$\frac{1}{2}$	5 %	5 %	5 %	6$\frac{1}{4}$— 6$\frac{3}{4}$	6$\frac{1}{4}$— 6$\frac{3}{4}$	6$\frac{5}{16}$	6$\frac{1}{4}$
33,129	Do. do. do. Def. Ord.	7$\frac{1}{2}$	...	...	1 %	4$\frac{1}{4}$— 4$\frac{3}{4}$	4$\frac{1}{4}$— 4$\frac{3}{4}$	4$\frac{3}{8}$	...
165,200*l*	Do. do. do. 6 % Debs. "A," 1910 ...	100	6 %	6 %	6 %	103 —107	103 —107	107	...
206,400*l*	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	6 %	6 %	6 %	103 —107	103 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	$\frac{1}{16}$%	$\frac{7}{16}$%	$\frac{1}{16}$%	$\frac{3}{4}$— 1	$\frac{3}{4}$— 1	$\frac{13}{16}$	$\frac{3}{4}$
34,563	Do. do. do. 6 % 1st Pref. ...	10	6 %	6 %	6 %	9$\frac{3}{4}$— 10$\frac{1}{4}$xd	9$\frac{1}{4}$— 10$\frac{1}{4}$	...	...
4,669	Do. do. do. 6 % 2nd Pref. ...	10	6 %	6 %	6 %	8$\frac{1}{2}$— 9$\frac{1}{2}$xd	8$\frac{1}{4}$— 9$\frac{1}{2}$	...	...
80,000*l*	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	5 %	5 %	5 %	110 —113	110 —113	110$\frac{1}{4}$	...
$1,177,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	113 —118	113 —118	...	...
164,300*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	101 —103	101 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4$\frac{1}{2}$%	4$\frac{1}{2}$%	5$\frac{1}{4}$— 5$\frac{3}{4}$	5$\frac{1}{4}$— 5$\frac{3}{4}$	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	14 — 15	14 — 15	14$\frac{7}{8}$	14$\frac{11}{16}$
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15$\frac{1}{2}$— 16	15$\frac{3}{4}$— 16$\frac{1}{4}$	15$\frac{7}{8}$	15$\frac{13}{16}$
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —136	133 —136	134$\frac{3}{4}$	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5$\frac{1}{2}$%	7$\frac{3}{8}$— 7$\frac{7}{8}$	7$\frac{3}{8}$— 7$\frac{7}{8}$	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2$\frac{1}{2}$%	3 %	10$\frac{3}{4}$— 11$\frac{1}{4}$	10$\frac{3}{4}$— 11$\frac{1}{4}$	11	10$\frac{7}{8}$
100,000*l*	Do. 5% Deb., bonds of £10, £20, £40	...	5 %	5 %	...	... — ...	... — ...	...	...
150,000*l*	Do. 4$\frac{1}{2}$% first mortgage debenture stock	...	4$\frac{1}{2}$%	4$\frac{1}{2}$%	...	117 —119	117 —119	118$\frac{1}{2}$	117
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	8 — 8$\frac{1}{2}$	8 — 8$\frac{1}{2}$	8$\frac{1}{4}$	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	7$\frac{1}{2}$%	4$\frac{1}{2}$%	6$\frac{1}{2}$%	8$\frac{1}{4}$— 8$\frac{3}{4}$	8$\frac{1}{4}$— 8$\frac{3}{4}$	8$\frac{3}{8}$	8$\frac{1}{4}$
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8$\frac{3}{4}$— 9$\frac{1}{4}$	8$\frac{3}{4}$— 9$\frac{1}{4}$	9$\frac{1}{4}$	9$\frac{1}{8}$
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3$\frac{1}{2}$%	4 %	5 %	7$\frac{1}{4}$— 8$\frac{1}{4}$	7$\frac{3}{4}$— 8$\frac{1}{4}$	8	7$\frac{7}{8}$

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, June 5th.	Closing Quotation, June 12th.	Business done during week ended June 12th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	6 % §	6 % §	...	2⅜ — 2⅝	2⅜ — 2⅝	2 9/16	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	2¼ — 2½	2¼ — 2½	2⅝	2 5/16
125,000£	Do. do. 4½ % Deb.	Stock	4½%	4½%	...	112 —115	112 —115	113¾	113
630,000£	City and South London Railway	Stock	⅝%	⅝%	1¼%	44 — 46	43 — 45	43½	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	2½ — 3	2 — 3	...	...
50,000£	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	5 %	5 %	5 %	no quotation	... — ...	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	½ — ¾	½ — ¾	9/16	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	1½ — 2	1½ — 2	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ...	2	*nil*	*nil*	...	... — ...	... — ...	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	1 — 1⅛	1 — 1⅛	1⅛	1
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	1⅛ — 1⅜	1⅛ — 1⅜	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	½ — 1½	½ — 1½	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½ — 7½	6½ — 7½	...	...
7,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	10 — 11	10 — 11	11	10¾
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	21½ — 22½	21½ — 22½	22 7/16	22½
200,000£	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	9 7/16 — 10	9 15/16 — 10 1/16	10	9 31/32
6,295	† Do. do. Pref., £10 paid	10	...	5 %	5 %	14⅜ — 15¼	14⅜ — 15¼	...	...
	Swan United Electric Light, Ltd.	...	10 % §	7½% §	...	... — ...	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	43 — 45	43 — 45	45	44
150,000£	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	106 —109	106 —109	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2¼ — 2½	2¼ — 2½	2 5/16	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.
Electric Construction Corporation, 6 % Debentures, 84—87.
Electric and General Investment, shares of £5 (£1 paid), no market.
House-to-House Company (£5 paid), 4—4½.
Do. do. 7 % Preference, of £5, 7½—8.
Do. do. 6 % Debentures of £100, 108—110.
Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 7½—8; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.
Liverpool Electric Supply, £5 (fully paid), 7½—7⅝.
London Electric Supply Corporation, £5 Ordinary, ¼—½.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, no market.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 5⅜—6¼.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

THE TELEPHONE SERVICE: PARLIAMENTARY INQUIRY.

(*Concluded from page* 705.)

The Select Committee of the House of Commons, inquiring into the working of the telephone service, sat for the last time for the purpose of taking evidence on Tuesday, May 28th, Mr. Arnold Morley, Postmaster-General, presiding.

Mr. J. S. Forbes attended to continue his evidence.

The CHAIRMAN: With reference to the document (the deed of the New and Mutual Companies) which you objected to produce at the last meeting; in deference to the wish of the Committee that the document should be produced, you withdraw your objection?

WITNESS: Entirely; I will hand in a copy of the document.

Sir CHARLES CAMERON: The point was the alleged stipulation in the agreement that the New Telephone Company should erect cheap double-wire exchanges in other towns, and also the limitation of rates.

WITNESS said the agreement was between the Mutual Company and the Electrical and General Investment Company. Amongst other things, it dealt with the transfer of the business of the Mutual, and a stipulation was that not more than £8 should be charged for the service at Manchester. There was also a clause with reference to the extension of that business, and a proviso with respect to the payment of £15,000 to the Mutual Company, as additional purchase money in regard to an extension of the business to other towns within 10 years. Clause 11 of the agreement stated that the purchasers of the business should, unless they gave sufficient reason to the contrary, erect, or cause to be erected, telephone exchanges in towns in Lancashire and Yorkshire of sufficient size, and work them, provided that two-thirds of the capital was raised locally.

Sir CHARLES CAMERON: Mr. Provand says that the Mutual Company sold themselves to the New Company by agreement, under which the New Company bound themselves, under a penalty of £15,000, to carry the policy of the Mutual Company, and erect double wire exchanges in other towns. That is practically the effect of this agreement?—That agreement is not with the New Company.

But the New Company bought the company subject to this agreement?—There was a Pioneer Company founded on that.

The National Company possesses all the shares of the New Company?—A considerable portion of them.

The CHAIRMAN: It has a controlling influence over the shares of the New Company?—Yes; the New Company is in process of liquidation.

Sir CHARLES CAMERON: Mr. Provand's complaint is, that the re-establishment of the monopoly by the Post Office enabled the New Company to obtain an enormous profit by selling itself to the National Company, and thereby evade the terms of the agreement. I do not ask you if that is right. Mr. Provand tells me he was offered a directorship of the National Company at that time and refused it?—That is not within my knowledge.

Is it within your knowledge that he was offered the managing directorship of the New Telephone Company and refused it?—No; it is not within my knowledge.

We will come to another point. I will ask you some questions about the financial position of the company; that is to say, the capital of the different companies absorbed by the National. Have you prepared any statement?—I do not know what the feeling of the committee is about that; I do not know whether it is within the reference of the committee.

Sir CHARLES CAMERON: My point is, that Mr. Forbes says higher charges, such as wages and rent, cause increased rates. My point is, that a much more important matter is the watered capital, and on that I ask Mr. Forbes the question.

WITNESS said he was entirely in the hands of the committee.

The CHAIRMAN said that if the committee put any question to Mr. Forbes which in his opinion might possibly damage the position of the company, he doubted if they would be justified in pressing it.

Mr. FORBES said that it was within the bounds of possibility that the Post Office and the company might be in arbitration hereafter as to the terms on which the company should be taken over, and they did not want to reveal too much.

The committee having ruled that the question was admissible,

WITNESS said that when the National Company, the United Company, and the Lancashire and Cheshire Company amalgamated, the stock was taken at market value, the old stock was cancelled, and new stock in the New Company given in exchange. They also absorbed the Northern District Telephone Company, the South of England Company, the Western Counties and South Wales, the Sheffield Telephonic Exchange, the Caledonian Company, the Isle of Man Company, the Universal Telephone Company, the Telephone Company of Ireland, the Thanet Telephone Company, and a small concern called the Home Telegraph Company. The total amount spent in the actual construction of these works was £1,813,000; the purchase value was £3,105,000; so that the amount which some people called watered value was £1,292,000. With the exception of

the National, the United, and the Lancashire and Cheshire, the other companies were taken over by negotiation. Since these companies had been united, beginning the year ending April 31st, 1890, to the end of December, they had spent £1,459,000, and therefore the construction account, dealing with it in that point of view, was £3,272,000; taking the value at £4,568,000, that left £1,292,000.

Sir Charles Cameron: The New company, of which you are also a director, have bought up several companies?—Yes; they bought up the Mutual and the Stanhope.

You have told us there were other companies interposed between the Mutual and the New Companies?—Yes; there was the Pioneer Company. These are financial machines invented by gentlemen in the City to raise capital. The Pioneer Company was started by the New Company as a means to start itself and absorb the Mutual Company, and carry out other obligations, including the City tubes.

They bought the Mutual Company of Manchester at a cost of 10 per cent. above cost price?—Yes.

Then the prospectus of the company to which your name appears bought up the Pioneer Company at about £87,000?—Yes.

So there was a considerable amount of loading?—There was some loading; £150,727 was the amount absorbed by the New Company, including the Pioneer Company.

Continuing, Witness said the National Company could have fought the New Company in London, but they knew that cost a great deal of money. He talked to them very seriously, and they came to an agreement. They agreed as to inter-communication, and to work the respective systems without rivalry. It was on that agreement that the National Company subscribed the money. The New Company was registered with a nominal capital of £750,000.

Mr. Benn: Did you pay £40 for each £1 founder's share?—Yes.

Sir Charles Cameron: Nothing was ever done?—Having got the money we had to consider how to apply it, and we came to the conclusion that the objects would be more economically and efficiently carried out by the National Company doing them.

This New Company in fact has never done anything?—Yes, they did something. They committed themselves to a good many items of waste.

You say your company has practically acquired the balance of shares. You do not get any interest on them?—It is part of our general capital. It comes into our capital account.

How does it stand in your account now?—As part of our capital expenditure.

What I want to know is the sum standing in the company's books?—The shares were £4 paid up. Part we converted into our shares at par. Part were paid off in cash which they raised on their own credit and which was part of the capital account.

You may say there is £700,000 unproductive capital?—Yes.

The Manchester business represents £60,000, and that leaves about £700,000 as unproductive and has been since 1892?—You can put it in that way. But you must bear in mind that we have been spending money in London for these improvements which they would have to do. It is cheaper to have done this in the way we have and therefore better for the telephone users. That is how we defend the transaction.

My point is that the interest which has to be provided on watered capital requires a higher charge to be made for the telephone service?—If we could get it for much less we should have been much better off, but then we can't get it.

You said you were acquainted with the policy of the Post Office at the time of the arrangement; was it before the House at that time?—I do not know that it was, but we were in negotiation with them all the time.

Your license comes to an end in 16 years?—Yes.

And the Post Office is not bound to buy you up?—No.

So that if there were three or four systems, they could buy either of them up?—Yes.

There is no obligation on the Post Office to pay even old iron value at the end of the 16 years?—I think there is no obligation whatever.

Mr. Benn, M.P.: You say that the average subscription is £9 2s. 2d.; but it is rather cold comfort to the London subscribers that the Manchester subscribers get the telephone cheaper?—Yes; but rent is higher in London, and you have to pay it.

Is it not a fact that where competition has reached a successful point, rates have been reduced?—There has been no successful competition.

I mean in Manchester and so on?—Yes, for a time; but you must also bear in mind that competition leads to waste, and then the charges must be put up.

According to the prospectus of the New Company, it shows that for 20,000 subscribers, £750,000 was to provide for that business?—Yes; it shows 10,000 in London.

Now, on that basis, £750,000 for 20,000 subscribers, I assume that 50,000 could be provided for for £18,750,000?—There is only the provision for a proportion of the necessary outlay for 10,000.

Yes; but there is the full complement of telephones here for the 20,000. This estimate is to cover the whole of the expense?—Yes.

Very well then, I ask you, if that be true with regard to 20,000, whether it is not fair to assume that 50,000 subscribers, about the number at present subscribing in Great Britain, ought not to be provided for on this basis for under two millions of money?—No.

But taking this as a basis?—You must consider the fact that this is a limited area.

But I am not taking a limited area. These 50,000 should be distributed over the whole country. I ask you to work the figures out on this basis, and ask if it is fair to assume that Great Britain could be telephoned for under £2,000,000?—It is absurd.

But on this basis?—Yes.

Now, I will give you a remarkable corroboration. With regard to the National Company, your expenditure up to December, 1894, is something like £4,400,000?—Yes, about that.

Well, if you deduct from that what you have spent in purchasing competitive undertakings, will you tell the Committee what it will leave?—What do you mean by the purchase of competitive undertakings?

You bought out various companies?—It cost £3,270,000.

Well, I have it in this way: I have your total expenditure and the total for the purchase of new undertakings. Deducting £2,250,000 from £4,430,000, that leaves a balance, presumably, for actual cost of efficient works of £2,179,000. Is that not rather a remarkable confirmation of the estimate of the New Telephone Company?—Let me get to our experience. You suggest that 50,000 subscribers could be supplied for double £750,000. Now, we have spent since the amalgamation in the years 1891, 1892, 1893, 1894, in hard cash, £1,459,000, over and above the expenditure up to that date.

But you have not repudiated my figures?—How many people do you want accommodated? Fifty thousand?

I take your figures in this prospectus, which you repudiate, but which eminent engineers consider true. I take your estimate for works, and for the purchase of competitive companies, and I find the figures almost tally, and I ask you if it is not a fair assumption that the figures put forward in your own name in 1892 were not correct?—No, I do not think they are correct. We only hoped that they would be realised. We were most anxious that they should be realised, and it was because we found that they were not likely to be realised that we resorted to another plan.

Sir James Ferguson next examined Witness, who, in reply to questions, said that the metallic circuit system would be completed, so far as London was concerned, at the end of the year. Manchester was being changed now. If they received the necessary facilities from the local authorities, the system in Glasgow would be complete within a year.

You, of course, desire to attract all the business people. Your object is to attract customers and develop your business as largely as possible?—Of course, we have the strongest inducement to do that. Our short tenure involves this. Unless our business largely increases, there will be no possibility of obtaining but a small share of our capital. I do not know what value to put on our machine when we leave it.

But as a commercial business, you want to extend as much as possible and meet the wishes of the public?—Yes; but even the wishes of the public are only second to our own salvation.

Your existence will, humanly speaking, cease in 1911. How long would it pay you to go on developing your business to meet the requirements of the public?—As long as any man with a sound actuarial mind could spend money on a continually decreasing tenure. That can only be determined by the increase of our business from year to year, and the amounts we are able to set aside for redemption.

Possibly in nine years it will not be remunerative to you to extend your capital expenditure?—Not remunerative to anyone on the tenure.

Then at that time the Government would have to make up its mind how the wishes of the public would have to be met. They would not be met by the ordinary operations of your company?—Of course, we should probably be driven by force of circumstances to say we cannot spend any more money.

In fact, at that time, either the need of telephones must be supplied by another agency, or you would have to ask the Government what they would do?—I think that inevitable. I think anyone who considers the position for a moment will see that. It is that, of course, which rather keeps up the price. Of course, if we had 25 years to run instead of 16, the question of price would at once assume a different position.

You have told the Committee that hitherto your development has been extremely hindered?—Under the first license extremely so; under the second license less so.

Now there are no hindrances other than the want of facilities?—No.

Given proper facilities there is no hindrance to your developing your system as much as possible, and it is to your interest to do so?—If we had facilities we should be able to supply it at a less charge.

Do your expenses decrease with increased subscriptions?—In some respects they do, but in others they would not. When you reach a particular level of subscribers in an area up to that point the more subscribers the better; but when you get beyond a certain number the complications are so increased that the cost becomes larger.

Then you have to sub-divide your area, and have a limited number of persons on each switchboard, which becomes more economical?—Yes; but there becomes a choice of evils.

I want to know whether it is your interest to develop the business, because if it appears that after a certain time it would be to your interest to discourage subscription that would tell the other way?—That has not yet arisen. It is our interest for some years to come to develop the business as rapidly as possible.

A contrast was made between the use of telegraphy and telephony, and I believe you said the telegraph was relatively much greater used in England than in other countries?—I produced figures to show that. In England there are 177 telegrams for every 100 of the population, whereas in German and other countries it is only 30.

That means that in England the telegraph lends itself more to business transactions?—Yes; where telegraphy is cheap and quick, as in this country, it is a very severe competitor of the telephone. But I believe on the completion of the trunk line system the telephone will be a much greater competitor with the telegraph, and that the telegraphic revenue will be seriously affected.

Mr. Tully: You say the trunk wires will affect the telegraph?—I think they will seriously affect it. The separation of trunk lines from the local service is based on the necessity of protecting the public revenue.

You state that £1,290,000 of your capital is watered?—No; some

people suggested it; it is described as watered, but there is a good deal of spirit in it.

A 5 per cent. dividend on that amounts to about £64,000 a year?—Yes.

And each telephone subscriber has to pay increased prices for his telephone to pay that?—Well, that is a proposition. I do not know that he does.

Well, how do you get the money to clear that?—From the subscriptions.

Therefore it has to be charged to each subscriber?—Yes; and anyone who attempts to found another telephone company will find himself exactly in the same position.

A corporation?—Yes.

The Glasgow Corporation?—Exactly so; they will have to charge a paying rate. They will have to raise money and pay interest.

But they will not have to pay 5 per cent. on watered capital?—I do not know that corporations will do it so cheaply. If they can start a telephone system without paying for it, it will be a very good thing. If these cheap rates are going to be brought about by corporations going on the rates, it means that merchants, manufacturers, and those who use the telephone, and who can well afford to pay a great deal more than they pay for it, will be relieved by the rates.

But the rates will be lessened by them having it?—I do not think a corporation should support the risks of a telephone service in order that merchants, tradesmen, and financiers should benefit who can well afford to pay for it.

But the taxes of the country suffer now?—I do not know. They get something. The telegraphic receipts are greater, but the working expenses are greater, also, and, therefore, it doesn't pay.

Your people objected to the people of Glasgow having the electric tramways?—I don't think so; we are delighted they should have them, even if they lose money on them; but not at the expense of stopping the telephone.

And a gentleman from Edinburgh said your company objected to them pulling down some old houses?—Well, I should be with them against pulling anything down in Edinburgh which is old. But I do not remember the circumstance. I suppose if we had the right to some old houses, we would maintain it. We have no rights whatever under compulsory powers. Any right we may have is by agreement. If we were in occupation of houses by agreement, and paid for it, we should maintain the right. If you invite complaints from people, you can also get complaints, particularly from imaginative persons. We do not want unlimited powers; we want defined powers. It is wonderful what has been done by this company to put up its machinery on sufference.

What remedy have the public if you supply an inefficient service?—I suppose a complaint to the Post Office; the Post Office has the power of listening to complaints. We are really licensees of the Post Office, and we consider our duty is to satisfy the Post Office.

But supposing the public do not have the service efficient and cheap, what remedy have they?—Their remedy would lay in the Post Office.

But in what way can they force them?—The Post Office has reserved the fullest rights for themselves in cases where a service does not exist or is inefficient, to compete with us.

And so to get rid of bad telephones the Post Office would start competition?—You can't carry on a business of this kind without complaints. I have heard complaints even about the Post Office. What is the average? People are always ready to make complaints, but they are not always reasonable. Poor telephone company!

You say the competition of the Post Office is the remedy against an inefficient service?—It is a good remedy. They can license anybody they please.

So competition would be a good thing in that case?—It would have the effect of pulling us up to the mark.

How can it be found out whether it is bad?—By taking evidence instead of rumour.

Would it not be better for the corporations to have the telephones?—No, it would be a worse thing, for the whole thing would be cut up.

But your business is cut up into local areas?—This is too delicate a matter to be cut up. It is a monopoly. It belongs to the Post Office now. We are mere agents.

You say this licence would be more valuable if it extended a longer period?—Yes, and also for the public, because we could reduce rates. A little sum in redemption would show you that.

If the Post Office entered into competition in a certain district in consequence of an inefficient service would they have to cut up that portion of your material in that district?—I do not think that there is any far-seated complaint to justify the Post Office in doing that.

Mr. Snape: You have described the working expenses as averaging £6 4s. 7d. What does working expenses include?—Everything; they are the whole cost of the work and maintaining from day to day.

Your charge to subscribers being 50 per cent. amounts to £9 2s. 2d.?—The working expenses are 62 per cent. of the receipts.

The balance is devoted to interest on capital and reserve for redemption?—Yes.

Practically, you are realising a profit of 50 per cent. above working expenses?—68 per cent. from 100 leaves 32 per cent.

Amongst these working expenses you have classified a certain amount for royalty, wayleaves, and taxes. Can you tell us how much of that sum is for wayleaves?—It is a very large sum.

Neither the way-leaves nor the rates and taxes would have to be paid if the telephones were in the hands of the municipalities?—I do not know that they would not have to pay wayleaves; they have no power to go over people's houses.

But the State would not have to pay these things?—It would be giving an article much below its value in order to reduce the public revenue. Every man in England for 6d. a day can get the use of the telephone. Can it be said the people who use the telephone are overcharged? And you are going to reduce that for what? Not to benefit the masses; they do not want the telephone. You will benefit the people who use it for commercial and social purposes, and who can well afford to pay for it.

You do not think the small tradesman and the less wealthy classes will be likely to use the telephone much?—No, I do not think so; at all events if they will they can.

Replying to further questions by Mr. Snape as to the increased cost per subscriber in connection with the multiple exchange boards, the Witness promised to prepare a statement and hand it in.

Mr. Snape: I do not know whether I ought to ask this. But in the event of the Committee thinking some change is desirable in telephone supply in the decision they might come to, would you prefer that they decide to buy your concern at a reasonable price for the State, or sanction licenses to municipalities to enter into competition, or to let the licenses run out, and then you not be entitled to receive anything?—You don't expect I am going to answer that offhand, do you?

Lord Stanley: In purchasing other companies, you have had to take all things into consideration; patents, goodwill, &c.?—We took them over as going concerns.

And in the case of the Post Office taking the business over, it would not be taken over as a going concern; the goodwill would lapse at the end of 16 years?—Certainly.

Therefore, the sum they would have to pay would be that sum spent in placing it in working order?—I think I should find out something more to claim.

If any other companies were started, they would have to be bought up on precisely the same terms?—I think that would be just.

And where there were rival companies, the Post Office would have to pay for both?—That is so.

And the two possibly might not pay?—Yes.

So the effect of having rival companies might be that the Post Office would have to buy non-paying concerns?—I think they would.

In the event of purchase by the Post Office, their object would be, I suppose, to give as good a service as you do, and at the same time to give it cheaper?—I fancy so.

If they reduced their prices, would that not cause at once a reduction in the number of telegrams?—I think it would be serious; it would be cutting off their nose to spite their face. Besides, a slight reduction in the tariff would do away with the profit made, and you would stand to lose by the reduced telegraph receipts, and also for the working expenses of the telephone absorbing the gross revenue from that source.

Witness further said he wished to make it clear about Manchester. The National Company had always maintained its rates and had increased the number of subscribers.

Mr. A. C. Morton, M.P., was called for the purpose of presenting the report of the Commissioners of Sewers regarding the service in the City. The clerk's report, as follows, was read and handed in:—"Agreeably to an instruction to ascertain the experience generally of telephone users in the City of London as to the efficiency and cost of the existing telephone service, I issued on the following day the circular, of which I append a copy, to the whole of the subscribers to the National Telephone Company in the City, numbering in all 3,456, directing their attention to the inquiry by the Select Committee of the House of Commons as to whether the provision now made for the telephone service is adequate, and whether it is expedient to supplement or improve this provision either by the granting of licenses to local authorities or otherwise. Answers were invited to the two following questions, and suggestions or remarks on the subject were solicited:—(1) Do you, as a subscriber to the National Telephone Company, consider their service efficient? (if unsatisfactory, state in what respect; (2) What is your opinion as to existing charges? I now have the honour to submit a list giving the names and addresses of the telephone users to whom the circular was addressed, and the replies that I have received, 1,085 in number, together with an abstract and summary thereof. Having very carefully perused and analysed these replies, I beg to report that the opinion of the majority as to the inefficiency and costliness of the service confirms in every particular the evidence given on your behalf by the chairman of the Streets Committee and myself to the Select Committee of the House of Commons now inquiring into the subject. How far the investigations of the London County Council, which were commenced the day before those of the commission affected the number of replies received by either body, it is very difficult to say, but there can be little doubt that the memorandum issued to their subscribers for signature by the National Telephone Company some time previously must, for obvious reasons, have drawn largely on the sympathy of telephone users, besides confining the issue to the narrow limits of an invitation to disapprove of the service being undertaken by the London County Council, coupled with a vote of confidence in themselves. I append a copy of this memorandum. It will be observed, nevertheless, that about one-third of the circulars issued have been responded to, and I think it may reasonably be assumed that the views expressed by the majority in regard to cost and efficiency represent the opinion of City telephone users generally. Of the replies, 690, or 63·5 per cent., condemn the existing system as inefficient from various causes, whilst 380, or 35 per cent. are satisfied with it; 909, or 84 per cent., think the cost excessive, and 109, or 10 per cent., do not object to the prevailing charges; 201 subscribers indicated what, in their opinion, would be a fair charge for a telephone, the sums mentioned varying from £1 10s. to £16. These prices quoted average, as nearly as possible, £10, which was the amount fixed by your Street Committee as being, in their opinion, a reasonable and sufficient rental (Streets Committee, Vol. xxi., f. 76). In analysing the causes of complaints, I have divided them under two heads, viz., affecting the system. The principal causes of complaint against the employés at the exchange

include the following: delay in answering calls, further delay in getting connected, incessant interruptions by exchange operators during a conversation, frequent cutting off whilst speaking, noise of voices at exchange, ringing of call bells in error, being placed by mistake in communication with wrong members, the obligation on the part of subscribers to ring up a second time when line is engaged, general inattention, incivility and impertinence, insufficiency of staff. The complaints against the system include—difficulty in hearing through confusion of sounds, frequent blocking of lines on account of the number of subscribers, instruments and wires continually out of order, and delay in repairing them, want of proper signals for disconnecting, defective insulations, bad service over trunk lines and to outlying districts. Amongst the remedies suggested are—adoption of the twin-wire system, increased staff at the exchange, second receiver to each instrument; additional trunk lines and call offices; improved switching facilities; better discipline at centres; employment of men or boys instead of women; wires to be placed underground; competition; State control; and control by local authorities. Although no direct question was asked on the subject, 132 subscribers have volunteered their opinions in regard to the future control of the telephone service, of whom 94 are in favour, and 38 are opposed to public control. A further analysis shows 56 of these 94 to be in favour of State control. It is quite clear that the evidence afforded by the replies to the inquiries condemns the existing telephone service as costly and inefficient."

Mr. Snape: Have you any replies from small tradesmen as to charge?—We have not many small tradesmen. But the general feeling is that it should not be more than £10 in London.

Lord Stanley: There are only 5 per cent. who admit that the service is inefficient?—I have had over 100 answers, and they are still coming in. It is not fair to draw conclusions from those who do not reply.

Mr. Beveridge appeared on behalf of the Glasgow Corporation, and handed in a petition signed by 970 subscribers to the telephone in Glasgow, declaring the service to be inefficient, inadequate, and expensive. The number of telephone users given in the book of the Glasgow district was 4,791, but some had more than one telephone, so that the real number of telephone users was 4,409. The circular was sent round by the Corporation to the telephone users.

Sir Charles Cameron: You have 970 names which can be actually identified from the books of the company?—Yes.

Mr. Lamb, in charge of the Telegraph Department of the Post Office, was recalled, and put in various statements bearing on the systems in operation in other countries.

Replying to questions, he said that it was true as stated by Mr. Forbes that the system in Germany was a single wire system. As a matter of fact although the German Government had no right yet they paid no wayleaves, whereas in England the Government had to pay wayleaves. A question had been raised that the rates in Rome, where there was competition, were lower than those of Milan where there was no competition. That was so, although since the competition in Rome started the Italians had passed a law against competition. In Norway an additional charge was made for a telephone which was transmitted to the telegraph, but under the agreement that facility would be free to English subscribers. There had also lately been modifications in the laws of Switzerland, by which a person holding 800 conversations in a year would have to pay substantially more than he did at present. There was wide divergence by the witnesses who put statements in as to the cost of the telephone system in London; specially between the London County Council and Mr. Preece. Major-General Webber also put in an estimate, but he admitted that the present charge of the National Telephone Company was not unreasonable for the service given. However, General Webber had made no provision for junction wires between exchanges, and he happened to know why. The Duke of Marlborough saw him several times at the Post Office, and wished the Post Office to lay the junction wires. Estimates were prepared by their late engineer. No actual agreement was arrived at, but they were the subject of mutual conversation, and they appeared to be accepted as reasonable. The estimate for junction wires for London generally was £178,000, and for the City itself the amount was about half that sum. Their late engineer gave it as his opinion that the tubes referred to which were laid in the City were not suitable for the Post Office, and his opinion was concurred in by Mr. Preece. He might also say that after careful inquiry it was ascertained as a fact that Major-General Webber estimated for more telephones in the City than there were tenancies. There were more telephone subscribers in the City of London than in Stockholm or Christiania.

This concluded the evidence, and the Committee will now proceed to consider their report.

THE NEW BOARD OF TRADE RULES.

The following draft regulations and conditions for securing the safety of the public and for ensuring a proper and sufficient supply of electrical energy, made by the Board of Trade under the provisions of the Electric Lighting Acts, 1882 and 1888, are now under consideration.

Definitions.

In the following regulations the expression "the Order" means the Order,

The expression "the undertakers" means the undertakers for the purpose of the order.

The expression "consumer's wires" means any electric lines on a consumer's premises which are connected with the service lines of the undertakers at the consumer's terminals.

The expression "aerial line" means any electric line which is placed above ground and in the open air.

The expression "pressure" means the difference of electrical potential between any two conductors through which a supply of energy is given, or between any part of either conductor and the earth; pressure on any alternating current system being taken to be the equivalent of pressure on a continuous current system when it produces an equal heating effect if applied to the ends of a thin stretched wire or carbon filament; and

(*a.*) Where the conditions of the supply are such that the pressure cannot at any time exceed 300 volts, if continuous, or the equivalent of 150 volts, if alternating, the supply shall be deemed a low pressure supply:

(*b.*) Where the conditions of the supply are such that the pressure may exceed the limits of a low pressure supply, but cannot exceed 3,000 volts, or the equivalent of 3,000 volts, whether continuous or alternating, the supply shall be deemed a high pressure supply:

(*c.*) Where the conditions of the supply are such that the pressure may on either system exceed 3,000 volts, or the equivalent of 3,000 volts, the supply shall be deemed an extra high pressure supply.

Mains, service lines, and other conductors and apparatus are referred to as low pressure, high pressure, and extra high pressure mains, &c., according to the conditions of the supply delivered through the same or particular portions thereof.

Where these regulations require any metallic body to be "efficiently connected with earth," it shall be connected with the general mass of earth in such manner as will ensure at all times an immediate and safe discharge of electrical energy.

Other expressions to which meanings are assigned in the order or principal Act have the same respective meanings in these regulations.

A.—Regulations as to Safety.

I. *General.*

Low pressure supply to consumers. (1.) Save as hereinafter provided the supply of energy delivered to the consumer's terminals shall be a low pressure supply.

Limitations of high pressure supply. (2.) A high pressure supply shall not be delivered to any consumer's terminals, except for special purposes, and with the approval of the Board of Trade on the joint application of the consumer and the undertakers, and subject to such further regulations as the Board of Trade may from time to time prescribe. But a high pressure supply may be given to distributing or converting stations, or to transforming apparatus on a consumer's premises in accordance with the following regulations.

Limitations of extra high pressure supply. (3.) An extra high pressure supply shall not be given except to distributing stations or other premises in the sole occupation of the undertakers, and with the written consent of the Board of Trade, and subject to such regulations and conditions as the Board may prescribe.

Limit of power in high pressure electric line. (4.) No high pressure electric line shall be used for the transmission of more than 200,000 watts, or in the case of an aerial line 50,000 watts, except with the consent in writing of the Board of Trade, and efficient means shall be provided to prevent this limit being at any time exceeded.

Quick-acting cut-off for high pressure lines, &c. (5.) Every high pressure electric line, conductor, or other apparatus shall be protected by a suitable automatic quick-acting cut-off.

Transformers. (6.) In every case where any transforming apparatus is used to convert a high pressure supply into a low pressure supply, some suitable automatic and quick-acting means shall be provided to protect the low pressure system from any accidental contact with or leakage from the high pressure system, either within or without the transforming apparatus.

Maximum current in conductors. (7.) The maximum working current in any conductor shall not be sufficient to raise the temperature of the conductor or any part thereof to such an extent as to materially alter the physical condition or specific resistance of the insulating covering, if any, or in any case to raise such temperature to a greater extent than 30 degrees Fahr.; and efficient automatic means shall be provided which will render it impossible for this maximum working current to exceed such limit to the extent of 50 per cent. even for short intervals of time; and special care shall be taken that the cross sectional area and the conductivity at joints are sufficient to avoid local heating, and that the joints are protected against corrosion.

Minimum size of conductors. (8.) The sectional area of the conductor in any electric line laid or erected in any street shall not be less than the area of a circle of one-tenth of an inch diameter, and when the conductor is formed of a strand of wires each separate wire shall be at least as large as No. 20 standard wire gauge.

Insulation test of electric lines. (9.) Every electric line shall be tested for insulation after having been placed in position, the testing pressure being at least 200 volts, and the undertakers shall duly record the results of the tests of each line or section of a line. No electric line shall be brought into use in which this test indicates an insulation resistance less than at the rate of 100 000 ohms per mile for every volt of pressure of the supply, unless it is connected with earth with the consent of the Board of Trade, in which case the insulation resistance of such electric line shall not be less than 10 megohms.

Maintenance of Insulation. (10.) The insulation of every complete circuit used for the supply of energy, including all machinery, apparatus, and devices forming part of, or in connection with, such

circuit, shall be so maintained that the leakage current shall not under any conditions exceed one-thousandth part of the maximum supply current; and suitable means shall be provided for the immediate indication and localisation of faults of insulation. Every such fault shall be remedied without delay.

Every such circuit shall be tested for insulation at least once in every week, and the undertakers shall duly record the results of such testings.

Provided that where the Board of Trade have approved of any part of any electric circuit being connected with earth, the provisions of this regulation shall not apply to such circuit so long as such connection exists.

Specification of insulating material. (11.) All material used for insulating electric lines or apparatus shall be of the best quality, and thoroughly durable and efficient, having regard to the conditions of its use. Suitable provision shall be made for the protection of the insulating material against injury or removal.

High pressure conductors to be covered. (12.) Every high pressure conductor shall be continuously covered with insulating material to a thickness of not less than one-tenth part of an inch, and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulating material shall not be less in inches or parts of an inch than the number obtained by dividing the number expressing the volts by 20,000. If this protection be wholly or partly metallic it shall be efficiently connected with earth.

Testing of insulation of all parts of any high pressure circuit. (13.) No electric line, machine, device, or apparatus, intended to form part of, or be connected with, a high pressure circuit shall be brought into use unless the insulation thereof has withstood the continuous application during one hour of twice the pressure to which it is intended to be subjected in use.

The undertakers shall duly record the results of such test.

Protection from lightning. (14.) Where any portion of any electric line or any support for an electric line is exposed in such a position as to be liable to injury from lightning, it shall be efficiently protected against such injury.

Accidents to be reported. (15.) Where any accident by fire or explosion, or any accident causing or likely to have caused personal injury occurs at any part of any electric line or work to which these regulations apply, the undertakers shall give immediate notice thereof to the Board of Trade.

II.—*Aerial Lines where erected with the necessary Consents.*

Maximum intervals between supports. (16.) Every aerial line shall be attached to supports at intervals not exceeding 200 feet where the direction of the line is straight, or 150 feet where this direction is curved, or where the line makes a horizontal angle at the point of support.

Supports, construction and erection of. (17.) Every support of aerial lines shall be of a durable material, and properly stayed against forces due to wind pressure, change of direction of the lines, or unequal lengths of span. The factor of safety for the lines and suspending wires shall be at least 6, and for all other parts of the structure at least 12, taking the maximum possible wind pressure at 50 lbs. per square foot. No addition need be made for a possible accumulation of snow.

Every support, if of metal, shall be efficiently connected with earth.

Attachment of aerial lines. (18.) Aerial lines shall be attached to insulators, and shall be so guarded that they cannot fall away from the support. Conductors covered with insulating material shall not be attached to the insulators by metal binders.

Height from ground and distance from buildings, &c. (19.) An aerial line shall not in any part thereof be at a less height from the ground than 18 feet, or where it crosses a street, 30 feet,* or within 5 feet measured horizontally or 7 feet measured vertically from any building or erection other than a support for the line, except where brought into a building for the purpose of supply.

Service lines from aerial lines. (20.) Service lines from aerial lines shall be led as directly as possible to insulators firmly attached to some portion of the consumer's premises which is not accessible to any person without the use of a ladder or other special appliance, and from this point of attachment they shall be enclosed and protected in accordance with the regulations hereinafter contained as to service lines on the consumer's premises. Every portion of any service line which is outside a building but is within 7 feet from such building shall be completely enclosed in stout India-rubber tubing.

Angle of crossing thoroughfares. (21.) Where an aerial line crosses a street, the angle between such line and the direction of the street at the place of such crossing shall not be less than 60 degrees, and the spans shall be as short as possible.

Crossing wires, &c. (22.) Where an aerial line crosses, or is in proximity to, any metallic substance, precautions shall be taken by the undertakers against the possibility of their line coming into contact with such metallic substance, or of such metallic substance coming into contact with their line by breakage or otherwise.

Suspending wires. (23.) Every high pressure aerial line shall be efficiently suspended by means of insulating ligaments to suspending wires, so that the weight of the line does not produce any sensible stress in the direction of its length. All suspending wires, if of iron or steel, shall be galvanised.

* Note.—In the county of London 35 feet.

Discharge of pressure in case of fire. (24.) In the case of an aerial line exceeding one half mile in total length, means shall be provided whereby the pressure may be discharged from any portion of such line erected over or alongside of any building or buildings without loss of time in case of fire or other emergency.

Maintenance. (25.) Every aerial line, including its supports and all the structural parts and electrical appliances and devices belonging to or connected with such line, shall be duly and efficiently supervised and maintained as regards both electrical and mechanical conditions.

Unused aerial lines to be removed. (26.) An aerial line shall not be permitted to remain erected after it has ceased to be used for the supply of energy, unless the undertakers intend within a reasonable time again to take it into use.

III.—*Electric Lines other than Aerial Lines.*

Conduits to be durable and strong. (27.) All conduits, pipes, or casings used as receptacles for electric lines shall be constructed of durable material, and of ample strength to prevent damage from heavy traffic, and where they are laid in streets in which gas mains are also laid shall be so constructed as to prevent any influx of gas from the adjacent soil.

Crossing pipes, &c. (28.) Where any electric line crosses, or is in proximity to any metallic substance, special precautions shall be taken by the undertakers against the possibility of any electrical discharge to the metallic substance from their line or from any metal conduit pipe or casing enclosing their line.

Electric continuity of metal conduits, pipes, or casings. (29.) All metal conduits, pipes, or casings containing any electric line shall be efficiently connected with earth; and shall be so jointed and connected across all street boxes and other openings as to make good electrical connection throughout their whole length.

Precautions against charging of short lengths of pipe, &c. (30.) Where isolated lengths of metal conduit, pipe, or casing are used for the protection of any electric line at road crossings or similar positions, there shall be interposed between such electric line and the conduit, pipe, or casing such additional insulating material as will prevent the possibility of any electrical charging thereof.

Precautions to be taken when bare conductors are used. (31.) Where the conductors of electric lines placed in any conduit are not continuously covered with insulating material, they shall be securely fixed in position, and no unfixed material of a conducting nature shall be contained in the conduit.

Adequate precautions shall also be taken to ensure that no accumulation of water shall take place in any part of the conduit, and to prevent any access of moisture to the conductors or the insulators; and the latter shall be so disposed that they can be readily inspected.

High pressure lines laid above ground. (32.) Any portions of any high pressure electric lines placed above the service of the ground, or in any subway, shall be completely enclosed either in a highly glazed porcelain tube embedded in brickwork, masonry, or cement concrete; or in strong metal casing efficiently connected with earth, and so protected and guarded as to prevent accidental contact with the casing.

Treatment of high pressure lines transmitting considerable power. (33.) Every high pressure electric line transmitting more than 50,000 watts, or used for the supply of energy to transformers placed in street boxes, shall, except within the generating station, be entirely enclosed in strong metal casing efficiently connected with earth, and such casing shall not contain any low pressure electric line.

Ditto where the power transmitted is not more than 50,000 watts. (34.) High pressure electric lines not intended to transmit more than 50,000 watts may be enclosed either as provided in the preceding regulation, or in glazed stoneware casings properly laid and jointed in cement at a depth of not less than 2 feet below the surface of the ground and sufficiently protected against breakage.

IV.—*Street Boxes.*

Precautions with respect to street boxes. (35.) All street boxes which contain any vacant space shall be so constructed as to prevent any influx of gas or water either from the adjacent soil or by means of any pipes, and ample provision shall be made by ventilation or otherwise for the immediate escape of any gas which may by accident have obtained access to the box and for the prevention of danger from sparking.

Covers of street boxes. (36.) The covers of street boxes shall be properly secured, and shall, where the box contains high pressure apparatus, be connected to strips of metal laid immediately underneath the adjacent roadway or pavement.

Casing of high pressure lines in street boxes. (37.) The casing of any high pressure electric lines shall be continued within street boxes.

V.—*Converting Stations.*

Converting stations. (38.) All converting stations, or points in a system of distribution to which a high pressure supply is given from generating stations, and from which a low pressure supply is given to consumers, shall be established in suitable places, which are in the sole occupation and charge of the undertakers.

VI.—*Consumer's Premises.*

Responsibility of undertakers for their lines, &c., on consumer's premises. (39.) The undertakers shall be responsible for all electric lines, fittings, and apparatus belonging to them, or under their control, which may be upon the consumer's premises, being maintained in a safe condition and in all respects fit for supplying energy.

Fire risks. (40.) In delivering the energy to the consumer's terminals the undertakers shall exercise all due precautions so as to avoid risk of causing fire on the premises.

Main fuses or disconnectors to be provided in a locked receptacle. (41.) A suitable safety fuse or other automatic disconnector shall be inserted in each service line as close as possible to the point of entry to any consumer's premises, and contained within a suitable locked receptacle of fireproof construction.

Treatment of low-pressure lines and apparatus. (42.) All low-pressure electric lines and apparatus placed on any consumer's premises shall be highly insulated and thoroughly protected against injury to the insulation or access of moisture, and no metal forming part of the electric circuit shall be exposed so that it can be touched. All electric lines shall be so fixed and protected as to prevent the possibility of electrical discharge to any adjacent metallic substance.

Transformers, &c., on consumer's premises. (43.) Where transformers are installed within buildings on consumers' premises, they shall be contained in a fireproof chamber securely locked, and the high pressure service lines in highly glazed porcelain tubes bedded in chases cut in brickwork or masonry.

Testing consumer's wires for leakage by undertakers. (44.) If the undertakers are reasonably satisfied, after making all proper examination by testing or otherwise, that a connection with the earth exists at some part of a circuit of such resistance as to be a source of danger, and that such connection does not exist at any part of the circuit belonging to the undertakers, then and in such case any officer of the undertakers, duly authorised by them in writing, or, if the undertakers so require, an electric inspector, may, for the purpose of discovering whether such connection with the earth exists at any part of a circuit within or upon any consumer's premises, at all reasonable times, after giving one hour's notice of his intention to do so, enter any such premises and disconnect the consumer's wires from the service lines, and may require the consumer to permit him to inspect and test the wires and fittings belonging to the consumer and forming part of the circuit.

In any case where the undertakers require the services of an electric inspector under this regulation they shall pay him the prescribed fee.

Supply to be discontinued if leakage exceeds a certain limit. (45.) If on such testing the officer or the electric inspector discovers that a connection exists between the consumer's wires and the earth, and that such connection has an electrical resistance not exceeding 5,000 ohms, or if the consumer does not give all due facilities for such inspection and testing, the undertakers shall forthwith discontinue the supply of energy to the premises in question, giving immediate notice of such discontinuance to the consumer, and shall not recommence such supply until they are reasonably satisfied that such connection with the earth has been removed.

Provided that in cases where the maximum power taken by any consumer exceeds 25,000 watts, the consumer's wires may be divided for the purposes of this testing into separate circuits, the insulation resistance of each of which shall exceed 5,000 ohms.

Appeal to electric inspector. (46.) If any consumer is dissatisfied with the action of the undertakers either in discontinuing or in not recommencing the supply of energy to his premises, the wires and fittings of such consumer may, on his application and on payment of the prescribed fee, be tested for the existence of connection with the earth by an electric inspector.

This regulation shall be endorsed on every notice given under the provisions of the last preceding regulation.

VII.—*Arc Lighting.*

Arc lamps to be guarded. (47.) All arc lamps shall be so guarded as to prevent pieces of ignited carbon or broken glass falling from them, and shall not be used in situations where there is any danger of the presence of explosive dust or gas.

Height from ground. (48.) Arc lamps used in any street shall be so fixed as not to be in any part at a less height than 10 feet from the ground.

Cut-off switch. (49.) A cut-off switch, fixed in a suitable locked receptacle, shall be provided for every high pressure arc lamp, and such switch shall be of such pattern and construction as will provide:—

(*a.*) That the lamp can by its means be entirely disconnected from the supply circuit;

(*b.*) That the switch itself can be safely operated in the dark by an inexperienced person and without special precautions; and

(*c.*) That there shall be no danger of any injurious electrical arcing, sparking, or heating being caused by the operation of the switch.

Penalties.

Penalties. (50). If the undertakers make default in complying with any of the preceding regulations, they shall be liable to a penalty not exceeding £10 for every such default, and to a daily penalty not exceeding £10.

The imposition of any penalty under this regulation shall not affect the liability of the undertakers to make compensation in respect of any damage or injury which may be caused by reason of such default.

B.—Regulations as to Supply.

Notice of intention to supply through mains. (1.) One week at least before the undertakers are ready to commence to supply energy through any feeding, charging, or distributing main, they shall serve a notice upon the local authority of their intention to commence such supply.

Undertakers to provide constant supply. (2.) From and after the time when the undertakers commence to supply energy through any distributing main, they shall maintain a supply of sufficient power for the use of all the consumers for the time being entitled to be supplied from such main; and such supply shall, except so far as may be otherwise agreed upon from time to time between the local authority and the undertakers, be constantly maintained. Provided that, for the purposes of testing, the authority by whom the electric inspector is appointed may give permission to the undertakers to discontinue the supply at such intervals of time and for such periods as it may think expedient, and that for any other purposes connected with the efficient working of the undertaking, the undertakers may, with the permission of the Board of Trade, discontinue the supply at such intervals of time and for such periods as the Board of Trade may think expedient. Where the supply is so discontinued, notice of such discontinuance, and of the probable duration thereof, shall be forthwith served upon the local authority.

Provisions as regards stoppage. (3) The system of distributing mains shall be so arranged that in case it becomes necessary to stop the supply through any portion of a main for more than one hour, for the purposes of repairs, or for any other reason, the stoppage of supply will in no case exceed in amount a maximum power of 200,000 watts, or extend to the premises of more than 80 consumers, and in the case of every stoppage for more than one hour reasonable notice shall be previously given by the undertakers to every consumer affected thereby except in cases of emergency.

Pressure in mains during supply. (4.) During the whole of the period when a supply of energy is required to be maintained by the undertakers in the distributing mains under the order and these regulations, it shall be maintained at a constant pressure (in these regulations termed the "standard pressure") to be fixed as hereinafter specified; but such standard pressure may be different for different portions of the distributing mains. Provided that the undertakers shall be deemed to have complied with the requirements of this regulation so long as the pressure does not at any point vary more than 3 per cent. from the corresponding standard pressure in the case of a general supply at low pressure, or 2 per cent. in the case of a general supply at high pressure, unless changes in pressure recur so frequently as to cause unsteadiness in the supply.

Fixing of standard pressure. (5.) The standard pressure shall be fixed by the undertakers for every pair of distributing mains, and notice of the amount of such standard pressure shall be given to the local authority before the undertakers commence to supply energy to consumers through such mains, and such standard pressure shall not be altered except by permission of the local authority, and upon such terms and conditions as the local authority may impose, and after public notice has been given during a period of one month, in such manner as the local authority may require, of the intention of the undertakers to apply for permission to alter the same. The undertakers may appeal against any decision of the local authority under this regulation to the Board of Trade, whose decision shall be final.

Declared pressure at consumer's terminals. (6.) Before commencing to give a supply of energy to any consumer, the undertakers shall declare to such consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared at any pair of consumer's terminals shall not, except by agreement be greater than 150 volts or less than 45 volts, if continuous, or the equivalents thereof respectively, if alternating, and shall not at any time be altered or departed from except in consequence of any authorised alteration of the corresponding standard pressure. In distribution on the three-wire system, the central terminal shall, for the purposes of this regulation be considered to form a pair with either of the outer terminals, and similarly for multiple-wire systems; and, in the case of a transformation of energy on the consumer's premises, the undertakers shall give the consumer the choice of a supply at either of two different pressures, one of which shall be approximately half the other, and in such case the pressure so chosen by the consumer shall be the declared constant pressure.

Variation of pressure at consumer's terminals. (7.) The variation of pressure at any consumer's terminals shall not under any conditions of the supply which the consumer is entitled to receive, nor at any time, exceed 4 per cent. from the declared constant pressure, whether such variation be due to the resistance of the service lines or apparatus belonging to the undertakers, or to any action or effect produced by such apparatus, for which the consumer cannot be shown to be responsible, or, partly to any variation of pressure in the distributing mains from which the supply is taken.

Penalty for default. (8.) If the undertakers make default in complying with any of these regulations as to supply, they shall, subject to the provisions of the order, be liable to a penalty not exceeding £5 for every such default, and to a daily penalty not exceeding £5.

These regulations are made subject to the power of the Board of Trade to make such further or other regulations as they may think expedient; and nothing in these regulations shall be construed to authorise the undertakers to lay any electric line or work their undertaking otherwise than in accordance with the order and the principal act, or to supply energy otherwise than by a system for the time being approved of by the Board of Trade under the order.

NEW PATENTS—1895.

10,334. "An improved arrangement of electric call or sounding apparatus." W. A. Price. Dated May 27th.

10,359. "Improvements in carriers for shades and like objects for

gas and electric light fittings and the like." E. W. Lancaster. Dated May 27th.

10,360. "Improvements in tumbler switches for electric circuits." E. W. Lancaster. Dated May 27th.

10,361. "Improvements in attaching metallic parts to porcelain and the like." E. W. Lancaster. Dated May 27th.

10,366. "A new or improved electrical stage effect and appliances therefor." D. Alexander and C. Hamilton, Limited. Dated May 27th.

10,408. "Improvements in or connected with apparatus for simultaneously shampooing and electrifying the human body." H. Simons. Dated May 27th. (*Complete.*)

10,418. "Improvements in or connected with time-recording apparatus for consumption of electric current." R. Wende. Dated May 27th.

10,433. "Improvements in dynamo-electric generators and motors." G. E. Dorman. Dated May 27th.

10,445. "Improvements in apparatus for electrolysis of alkali salts with quicksilver as cathode." H. C. F. Stormer. Dated May 27th. (*Complete.*) [Date applied for under Patents, &c., Act. 1883, Section 103, November 26th 1894, being date of application in Norway.]

10,448. "Improvements in secondary or storage batteries." L. Falero and H. Lumley. Dated May 27th.

10,480. "Improvements in methods of supplying electricity to arc lamps." A. Wright. Dated May 27th.

10,502. "Improvements in movable pendants and brackets for suspending and carrying electric gas or oil fittings and for other purposes." E. W. Lancaster. Dated May 28th.

10,518. "A self-contained electrical grinding machine." C. Fane. Dated May 28th.

10,535. "An automatic device for use with electric motors." C. B. Callow and H. J. Eck. Dated May 28th.

10,536. "An automatic device for starting electric motors." C. B. Callow and H. J. Eck. Dated May 28th.

10,538. "Improvements in dynamo-electric generators and motors." G. E. Dorman. Dated May 28th.

10,539. "Improvements in dynamo-electric generators and motors." G. E. Dorman. Dated May 28th.

10,541. "An improved accumulator and redistributor of energy for cycles, trams, trains, and other vehicles." D. E. Hipwell. Dated May 28th.

10,569. "Improvements in electrical apparatus for lighting gas." E. Massy. Dated May 28th.

10,587. "Improvements in and relating to electric heaters." C. J. Reed. Dated May 28th. (*Complete.*)

10,604. "Improvements in insulators or insulated connections for telegraph, telephone, and other electrical wires." R. Taylor. Dated May 29th.

10,614 "Improvements in or relating to electric telephone systems." T. Sloper and G. E. Beckett. Dated May 29th.

10,647. "Improvements in the electrical propulsion of boats and vessels." A. G. New and A. J. Mayne. Dated May 29th.

10,655. "Improvements in and connected with arc electric lamps." G. Binswanger and A. E. Angold. Dated May 29th.

10,656. "Improvements in and connected with arc electric lamps." G. Binswanger and A. E. Angold. Dated May 29th.

10,660. "Improvements in or relating to electric contact makers." J. D. Stuart. Dated May 29th.

10,672. "Improvements in apparatus for measuring or indicating the frequency of alternating or pulsating electric currents or potential differences." A. Campbell. Dated May 29th.

10,679. "Improvements in or connected with furnaces or apparatus in which materials are fused by means of an electric arc." D. B. Morison. Dated May 29th.

10,685. "Improvements in electrical thermometers." G. C. Whipple and H. E. Warren. Dated May 30th. (*Complete.*)

10,687. "Improvements in the arc striking and feeding devices and arc lamp frames for arc lamps, more especially applicable to those arc lamps used singly, or two or more in series across incandescent or constant potential mains." F. D. Goold. Dated May 30th.

10,696. "Improvements in and relating to electro-plating ships, vats, and other articles." J. H. Cox. Dated May 30th.

10,730. "Improvements in photometers." F. H. Nalder, C. W. S. Crawley, A. Soames, and A. P. Trotter. Dated May 30th.

10,746. "Improvements in or relating to the connecting and disconnecting the sockets of incandescent electric lamps." P. Benham and W. Smith. Dated May 30th.

10,778. "Improvements in dynamos and motors." J. Perry. Dated May 31st.

10,779. "A new method of and apparatus for the conversion of heat energy into mechanical energy and into electrical energy." F. Hamer. Dated May 31st.

10,792. "An improved dry battery for electrical purposes and material for packing same." W. Elliott. Dated May 31st.

10,810. "Improvements in electric tramways." R. E. B. Crompton. Dated May 31st.

10,816 "Improved method of installation for electrical conductors within buildings, and casings and appliances therefor." H. W. Handcock, A. H. Dykes, and R. S. Lloyd. Dated May 31st.

10,817. "Improvements in joint blocks or boxes for electrical conductors and the combination thereof with the conductor casings." H. W. Handcock, A. H Dykes, and R. S. Lloyd. Dated May 31st.

10,836. "Improvements in storage batteries." C. Payen. Dated May 31st. (*Complete.*)

10,875. "Improvements in means of lighting cigars, cigarettes, and pipes by electricity." J. W. Collings and W. Friese-Greene. Dated June 1st.

10,895. "An improved electric light standard for workshops and the like." G. Stegmann. Dated June 1st.

10,929. "Improvements in apparatus for electrolysing chloride solutions." E. Hermite, E. J. Paterson, and C. F. Cooper. Dated June 1st. (*Complete.*)

10,930. "Improvements in apparatus for electrolysing chloride solutions." E. Hermite, E. J. Paterson, and C. F. Cooper. Dated June 1st. (*Complete.*)

10,951. "Improvements in secondary batteries." E. Freund. Dated June 1st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1894.

6,888. "Improvements in telegraphic and telephonic apparatus." J. Imray. (Communicated from abroad by La Société Anonyme pour la Transmission de la Force par l'Electricité, of Paris) Dated April 6th. Relates to telegraphic and telephonic apparatus, so constructed and arranged that the receivers at a station select and separate only those signals which are specially addressed to them without being acted on by any other signals that are at the same time transmitted along the line. For this purpose, transmitting instruments are provided to send along a line electric undulations of various periods, each instrument determining a particular frequency of undulation. 3 claims.

6,912. "Improvements in and relating to moulds for casting grids for the active material of electrical accumulators." G. Hagen and C. Beyer. Dated April 6th. The plates of the mould are provided with ribs running parallel to one another on each plate, which, instead of being upright are inclined to the plate so that one side of the ribs forms an acute angle and the other side of the ribs an obtuse angle with the surface of the plate. On both plates the ribs have the same angle of inclination, the same depth and are at the same distance from each other. The two plates are so guided in a frame that they can be moved at the same angle at which the ribs are inclined, towards each other for closing the mould in order to effect the casting, and away from each other for opening the mould in order to lay bare the grid formed. 1 claim.

7,054. "Improvements in electrically-propelled vehicles." E. J. Clubbe and A. W. Southey. Dated April 9th. Claim:—In an electrically-propelled vehicle, mounting each motor and an intermediate shaft driven direct therefrom, to slide or move together upon the vehicle body, and coupling the said intermediate shaft or its support to the axle of the wheels to be driven, by a radius link or links whereby to maintain constant, or approximately so, the distance between the intermediate shaft and axle, notwithstanding the play of the springs interposed between the axle and body, substantially as specified.

7,853. "An improvement in the electro-deposition of heavy metals with a base metal alloy." W. A. Thoms and W. H. Burgum. Dated April 20th. Has for its object the obtaining deposits of a white, hard, reguline nature, and also of depositing an alloy of greater cheapness, both with regard to the metals used and to the chemicals that form part of this process, than has hitherto been in use. 1 claim.

9,456. "Improved junction or fuse box for electric wires." C. N. Russell. Dated May 12th. This invention relates to junction or fuse boxes for electric wires, the object being to provide them with porcelain or other non-conducting fittings for the connection, perfect insulation, and distribution of electric wires from the main cable to the lamps, or other position where a supply of current may be required; also to construct such junction boxes that water cannot penetrate through the joint between the cover and the shell of the box. 2 claims.

18,480. "Improvements in automatic electrical gaslighters." W. N. Jaskey and E. S. Else. Dated September 29th. Claims:—1. In an automatic electrical gaslighter, the combination of an electrical magnet with the connection fitted to a burner holder, and the cut-off attached to the cock plug and bracket arm, substantially as described and for the purpose specified. 2. In an automatic electrical gaslighter, the combination of the fan support fitted to the elbow cock with the connection at the top of fan support and the pivoted fan and screw weight, substantially as described. 3. In an automatic electrical gaslighter, the apparatus for passing of a current through the magnet to cause the arm to vibrate, and making a spark to light the gas, substantially as described.

22,966. "Improvements in or relating to the production of compounds applicable for such uses as for paints, for electric insulating and waterproofing, as substitutes for vulcanisable rubber and gum compounds, and for other purposes." W. P. Thompson. (A communication by W. Griscom, Jun., of New Jersey. Dated November 27th. Is based upon the discovery of the fact that the residual products from the distillation of animal fats, oils, &c., can be combined with sulphur and then developed into a vulcanised mass, possessing some of the elastic and other desirable characteristics of vulcanised caoutchouc or rubber compounds. 8 claims.